THE

ELECTRICAL REVIEW.

VOL. XXXIV. MARCH 30, 1894. No. 853

CONTENTS:

	PAGE
Ship Lighting...	357
Rules and Regulations for Electric Lighting Steamships.—V.	359
The Electrical Treatment of Infantile Paralysis	360
The Scientific Study of Arc Lamps.—VII. (*illustrated*)	362
Morton's Steam Turbines (*illustrated*)	363
Electricity Supply Stations.—No. 16.—Brussels Municipal Station (*illustrated*)	365
Correspondence:—"Science Siftings"	368
A Strange Tale of a Motor	368
The Heilmann Locomotive	369
Balancing in a Three-Wire System (*illustrated*)	369
Lightning Express	369
A New Key for Lamp-post Switches	370
Theryc-Oblasser Battery	370
Method of Approximately Determining the Magnetic Field at any Point Inside a Circle Carrying a Current (*illustrated*)	370
A Quack Sentenced to Five Years' Imprisonment	372
Business Notices	373
Contracts Open and Closed	374
Notes	374
City Notes, &c.	377
Traffic Receipts	378
Share List of Electrical Companies	379
Reviews:—Electric Traction	380
The Inventions, Researches, and Writings of Nikola Tesla	381
Electricity in the Service of Man	381
Spon's Architects' and Builders' Price Book for 1894 ...	381
Various Systems of Underground Mains and Methods of Laying Same (*concluded*)	382
Proceedings of Societies:—	
The Institution of Electrical Engineers	383
Société Internationale des Electriciens	383
New Patents	384
Abstracts of Published Specifications	384

THE
UNIVERSAL ELECTRICAL DIRECTORY
(J. A. BERLY'S).

PRICE 4/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1894 ISSUE NOW READY

PRICE 4/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address "AGENCY, LONDON." Code A B C. Telephone No. 517

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *Foreign Countries* (except those mentioned below), per Year, £1 1s. 8d. *Exceptions.*—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (*viâ* Brindisi), Phillipine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 2s, 10d.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

SHIP LIGHTING.

THE correspondence which we have received during the past few weeks on the subject of ship lighting shows a marked unanimity in condemning inferior work, and the plea put forward in this journal for strict supervision meets with general acceptance. Whether we shall get beyond the condemning stage remains to be seen. Combined action of electrical men might do something towards modifying the extraordinarily loose conditions which prevail in ship wiring, and if pressure were brought to bear somewhere, we might arrive at a better state of things; but the precise direction which this pressure is to take is hard to see. We cannot push against a body which offers no resistance, and this almost represents the position we have reached with regard to improving ship wiring. The condemnation of bad work is, perhaps, the only matter upon which our correspondents are in unison. When we come to the question of the most suitable system of wiring for ships, the diversity of opinion becomes almost alarming. Single wiring, concentric, and double wiring have each their advocates, and a good deal would have to be written to convince any one of the three that his system was inferior to the others. None of the three systems can be pronounced totally bad. Objections are frequently raised against single wirings on the grounds of interference with compasses, and no doubt some exaggerated notions of the danger were spread abroad when Lord Kelvin pointed out a possible source of error in ship compasses when a single wiring system was close at hand. That there is a chance of interference with compasses few would care to deny, and it is not surprising that many contractors with a reputation to lose have stuck throughout to double wiring; on the other hand more than one firm of undoubted standing, impressed with the adequacy of the single-wiring system, still adheres to it. We learn that exceedingly good results have been obtained with the concentric system, and it would seem that this offers distinct advantages. It is clearly established that none of the bad work, to which we recently drew attention, was due in any way to inherent defects of the system which happened to be employed. Poor unsupervised work will level all systems.

A good deal of the correspondence has arisen out of Mr. Rankin Kennedy's articles on "Rules for Ship Wiring." It would have been better, though inconvenient, if our correspondents, before criticising, had waited for the issue of the complete series. The rules embodied in these articles were put forward as suggestions to be fairly discussed. Mr. Kennedy has not been altogether fortunate in his terms, and to this misuse, or what seems to us misuse, a good deal of personal bitterness imported into the discussion has been due. There is little doubt that what Mr. Kennedy understands by single wiring is known to others as concentric. While admitting that concentric cannot be well described as double-wiring, single-wiring fails altogether to express it.

Mr. Newitt detailed some interesting and important experiments carried out at Elswick on disturbances of compasses due to single wiring. Unfortunately, the serious objection of not approximating to actual practice must be urged against these tests. The effects derived from a main carrying 100 ampères was noted on the compasses, and it was found that the iron hull of the ship exercised little screening effect. This is what we should have expected, but then mains of such a carrying capacity as that used by Mr. Newitt are rarely, if ever, used in ship lighting. To show that the matter has not assumed serious proportions, we must point out that there are numerous ships wired on the single wire system which never traverse out of the beaten track, on account of defective compasses. We would not say that no danger could possibly arise from this system, and the fact that errors in compasses have been rarely traceable to single wiring must not be made too much of. It must be understood that we are carefully distinguishing between single wiring and Mr. Kennedy's concentric system.

We must express entire agreement with Mr. Kennedy when he says that the making of good joints, and the preservation of conductivity, is of the utmost importance. The great source of weakness in all wiring is at the joints, and the most satisfactory system would be that which had the fewest. An absolutely jointless system is an impossibility; but it surely is possible to devise a method which will provide for the localisation of all possible sources of weakness.

It should not be forgotten that the maintenance at sea of electric light plant depends a good deal on the ship's officers, and an absolutely safe system, if complicated, might, in the event of alterations, become positively dangerous. If every ship carried an electrician, matters would be different; but the most likely time for the electric light to go wrong would be in mid ocean, and surely a system which was easily understood by the ship's engineers would commend itself under such circumstances. The exigencies of ship life render permanency an impossibility.

In this issue Mr. Kennedy concludes his series of articles with a set of suggested rules, based to some extent on those put forward by Lloyds. We must admit that they would have met with more general acceptance if their scope had been wider. As they stand, they entirely exclude single wiring, and it is not everyone who will agree with this exclusion. In most other respects the rules are admirable, and would form a fairly sound basis on which to draw up a set of rules. We do not think that any useful purpose will be served by unnecessarily prolonging the correspondence on this subject, and we propose to close our columns after the next issue.

The Northern Society of Electrical Engineers.

THE quality of the papers and the tone of the discussions which have marked the opening session of the new society would lead us to prophesy for it a useful career. To be helpful to its members, such a society must be, above all things, practical. It must encourage, nay almost insist upon, the treatment and consideration of subjects which have a direct bearing upon the daily work of the electrical engineer. The utility of the Northern Society lies mainly in this direction. We cannot conceive that an electrical society which met to discuss theoretical matters, would be likely to flourish in Manchester. To attend the meetings, many of the members will be compelled to travel considerable distances, but few would object to this if they were certain to derive benefit from practical discussions. The number of electrical men in the north has been steadily growing; to them and to their new organisation we look for the adequate ventilation and proper discussion of subjects which, for some reason or other, have been greatly neglected by the older society. We expect the Northern Society to exhibit a strong *esprit de corps*. We look for an entire freedom from *cliqueism*, and we trust that it may not suffer from the cramping effects of "precedent" which too often overshadow the initiative action of societies as well as legislatures. The important subject of underground mains has been recently discussed by the Society and reported in our columns. The papers were distinctly useful, and the discussion thus far has been interesting. We sincerely hope that the Society will go on as it has begun, and, by means of serious essays and earnest discussions, help us to a proper appreciation of the problems that are met in actual work.

Conductivity of Copper in Various Media.

MESSRS. HUGH RODMAN and Fred. L. Keeler have lately been investigating the electrical conductivity of copper, with a view to determining the effect of the insulating medium upon the measured resistance. The experiments were undertaken at the suggestion of Prof. Carhart, for the purpose of confirming or refuting the conclusions of Prof. Fernando Sanford upon this point, whose results were supposed to show that the dielectric affects the conductivity of the copper, and that the resistance of a given wire is different in different liquids and gases. With a more sensitive apparatus, however, the tests made by Messrs. Rodman and Keeler seem to indicate no such want of harmony. A series of observations were taken a number of times, using the dielectrics: air, alcohol, and kerosene in various orders; also a mixture of alcohol and kerosene; but in no case was a difference in resistance, ascribable to such a cause, detected; and the conclusion pointed to is, that Prof. Sanford's measurements were affected by some systematic error which he did not eliminate. The researches of Sanford were published in *Phil. Mag.*, January, 1893; and these of Rodman and Keeler will be found in the *Physical Review* for the present month.

Commercial Progress of Electricity.

MAJOR FLOOD PAGE, in a letter to the *Times*, of Tuesday, ably summarises the present position of electric lighting. He draws a comparison between the early history of gas and electrical enterprise which we do not remember to have seen before. On May 13th, 1879, Mr. Corbett Woodall, C.E., engineer-in-chief of the Phœnix Gas Company, gave evidence before the Parliamentary committee, and said, "As a rule in early years gas companies did not pay any dividend at all, or a very small one. Before coming away I sought to find the dividends paid by my company since 1824. I was unable to find them up to 1851, but I believe they never reached 3 per cent. before 1851." That is for 27 years. Surely, as Major Flood Page suggests, we have good ground for hope. We wish we had space to quote more of the Major's admirable digest of the position. In dwelling for a moment on the telephone business, he protests against the muddle which the Government has introduced into the telephone business, and is of opinion that the sooner the Government purchase the whole of the telephonic interests the cheaper will be the price to be paid, and the more efficient will the service be made. The Major brings a cheery optimism to bear on the electric traction question, and is sanguine enough to anticipate that the experiments made recently by two French engineers will have a great effect on the progress of electric lighting.

RULES AND REGULATIONS FOR ELECTRIC LIGHTING OF STEAMSHIPS.

By RANKIN KENNEDY.

V.—Conclusion.

Fittings may be double or single wired, but must be watertight perfectly in both cases; it will be found much easier to meet this requirement in single wired fittings. Besides, these fittings make good central contacts without joints. It has been objected that these detachable fittings with central contacts work loose, and break off contacts; if they do they must be jerry fittings, for some central contact fittings are, to my knowledge, firm and fixed in more than one ship which have carried them for over ten years without the slightest trouble. It is just as easy, surely, to make a single wired central contact fitting secure and firm, as it is to do so with a double wired fitting. If not, why not?

Without expressing any further opinions or entering into any more *pros* and *cons* on the subject, I will submit amended rules, choosing as a basis the suggestions of Lloyds' Register, as they are pretty well known, and copies may be had. They are also printed *in extenso* in Prof. Jamieson's "Rules and Tables," tenth edition. I will take them *seriatim*, and make changes, alterations, and additions, in italics, and delete whatever I think should not be included.

(1) Ordinary dynamos and motors should be placed as far as possible from all compasses, and should be 30 feet at least from the standard compass. *Ironclad type of dynamos or motors may be used closer to the compasses.* The compasses should be adjusted with the dynamos *and motors at rest.* The ship should then be swung with the dynamos and motors fully excited, but not lighting any lamps, on one test, and switching on and off the various circuits in another test, on each course. Any deflections due to the dynamos must be remedied *first, and then any deflections due to the currents must be remedied* afterwards.

(2) and (3) to be deleted.

IV. Leads or circuits = 1, remains unaltered.

(2), (3), (4) and (5) remain unaltered.

(6) The leads *as far as possible* should be placed where they can be accessible. *In the alleyways, engine room, stoke hole, shaft tunnel, galley, on upper decks, and all other places exposed to weather, oil, steam, water, or heat, the leads must be thoroughly protected by lead covering, galvanised iron wire armouring, or concentric return metallic covering, and no wood casing shall be allowed to be used in these places except as a covering for these lead covered, wire armoured, or concentric leads. Leads in cabins, saloons, and other dry places, may be run in wood casing screwed on and with screwed on covers, but all cables led through cargo spaces, coal bunkers, or spaces which may at any time be used for cargo or baggage, or which are not at all times accessible, must be lead covered, iron armoured with galvanised iron wire, or concentric cables.*

(7) and (8) delete.

(9) Unaltered.

(10) Add "*And the backblocks containing the contact terminals must be of iron or other unbreakable material, and to screw down perfectly watertight.*"

V. Joints = 1. Joints, after being carefully soldered and insulated, must be encased in a satisfactory watertight junction box of metal, or a metal protector cast over it. If lead-covered wire, the joints should be covered over by a sound plumber's junction.

(2) Joints in branches. *For main branches, and all branches in the places where lead covered, iron armoured, or concentric wiring, has been specified as hereinbefore, must be encased in satisfactory watertight metallic junction boxes, cast protectors, or if lead covered, by proper plumber's joints. Joints in small leads in cabins, saloons, and other dry places may be protected by wood casing* only, but the insulation must be *very* carefully carried out *at these joints, as they must be watertight.*

(3) Unaltered.

(6) *Joints with hull to be allowed with concentric wiring. On this system the outer conductor may be grounded. Single wiring without concentric return shall not be allowed, nor the hull alone to be used as the return.*

VII. Switches and fuses (1), (3), (4), (5) and (6) unaltered.

(2) Add: "In the places where lead covered wires, iron armoured wires, or concentric wiring only is allowed, metal cased switches and fuses must be used, and they must be perfectly watertight in themselves."

VIII. Tests = (1), (2), (3), (4), (5), (6), and Prof. Jamieson's = unaltered.

(9) Petroleum carrying vessels = add: "Lamps should be fitted in large groups, with the smallest number of switches possible."

Masthead light to be fitted with two lamps, and to be connected with a triple conductor, so that one lamp may be switched on if other is extinguished. The masthead lamp should be a fixture, and not swung on rope guys; the leads to the masthead, port, starboard and anchor lights must be lead covered, iron armoured, or concentric for thorough protection.

Compasses are frequently fitted with electric lamps quite successfully, a concentric or twin wire lead being used, thoroughly protected from water.

Small fuses from 1 to 5 ampères must be of such a type that a larger fuse cannot be inserted into a cut-out than the size it is made for, and the ampères for which the cut-out and the fuse are made must be clearly printed or stamped on both.

All the joints, junction boxes, protectors, wires, fittings, switches and fuses, shall be inspected by a competent inspector, with power to condemn anything found not in accordance with these rules and regulations.

It will be seen that these rules leave the choice of several good systems, while they absolutely prohibit the jerry wiring materials where they are dangerous.

Inspection, of course, would go a long way to secure good workmanship in any system, but the best of workmanship, with a bad system and materials, is not of much value; prohibitive rules alone can provide for these.

It has been said that such rules, if compulsory, would raise the cost of ship lighting so as to make it altogether prohibitive. I cannot see why it should; the concentric system in which the outer conductor fulfils also the office of protector is not an expensive wiring, and the watertight junction boxes and switches, when made in a methodical, engineering way, are just as cheap as the rickety, lacquered, and enamelled affairs, called junctions and switches, made by gas fitters and brass finishers. Competition would still go on under the rules, so that there would be no fear of the shipbuilder or owner not getting full value for his money spent on ship lighting if he takes the ordinary precautions to obtain a fair estimate by submitting a complete specification to competent firms. If shipbuilders would obtain fair prices and a good job, they must be very careful in this matter of specifying exactly what is wanted. There is experienced assistance to be had in drawing up specifications in plenty, and the money spent in securing it is always far more than saved in the end.

As for dynamos, I much prefer the ironclad type for ship work; it has the smallest possible external field, and it is well protected by the external iron case.

It is a moot question whether the alternating current machine is not the best of all. In ships, electric power will some day become popular; when that comes about, the commutatorless motor will be adopted, and that requires the alternating current, and alternating dynamos are simpler, and require less attention.

For engines, the steam turbine or single-acting inverted vertical engines are, in my experience, preferable. It is somewhat curious in regard to engines that I have sometimes found the best engine to be offered at a price a long way cheaper than others; in fact, a difference in price as great as 50 per cent. has been quoted, the lower-priced engine being the best of the two. It has often been a matter of comment that marine engineers pay, without objection, fancy prices for small engines favoured by them, while they with difficulty agree to pay for wiring a price which little more than covers the cost of copper. It is high time something was done to convince them that the wiring of a ship is of far more importance than the choice of an engine.

THE ELECTRICAL TREATMENT OF INFANTILE PARALYSIS.*

By H. LEWIS JONES, M.D. Cantab., M.R.C.P.,
Medical Officer in charge of the Electrical Department, St. Bartholomew's Hospital.

The points which I propose to bring before the notice of the society to-night are some which have cropped up from time to time in the past three years of work in the electrical department of St. Bartholomew's Hospital, where I have had opportunities of continuously watching the progress of many cases of infantile paralysis for long periods of time.

The long lasting paralysis and atrophy which this disease so often leaves behind it tends very greatly to discourage one's efforts of treatment, and indeed it is only by watching and treating patients for months or years that their slow and gradual improvement becomes perceptible, as the result of an electrical testing which has shown seriously impaired reactions. Many people have been told that their children were beyond reach of treatment in the more severe cases. It is quite certain, though, that prolonged electrical treatment will do much good to nearly all cases of infantile paralysis, provided that the children are young and not more than two or three years have gone by since the incidence of the disease. Even after that lapse of time something may be done.

In an electrical department cases of infantile paralysis are apt to collect together in great numbers, and indeed they may become so numerous as almost to monopolise the whole energies of the department. Soon after commencing the electrical treatment of this disease it occurred to me one day that the numbers in attendance were becoming unmanageable, and that it might perhaps be as well to discharge some of the most unpromising cases, but I found that the mothers of the children were unanimous in declaring that the treatment was doing good, and that they all begged to be allowed to continue attending longer. As this was encouraging, I thought it would be profitable and interesting to watch the cases more closely and for a longer period, in order to see whether some satisfactory progress might not be gained. Since then I have been able to recognise the improvement, and to discharge very considerably improved a fair number of children who came under treatment in a more or less crippled condition.

There is a formula in which the prognosis of infantile paralysis has been commonly summed up. It is as follows: If the ganglion cells supplying the muscle are destroyed recovery must be impossible, and if the cells are not destroyed treatment is unnecessary, because the patients will get well of their own accord. This formula, I am sure, has done a great deal of harm, for it is widely accepted because it saves such a lot of trouble. But it starts from the assumption that the disease must either destroy all the motor cells of a muscle or else must leave them all uninjured, and this assumption is certainly not correct. On the contrary, the damage to the motor cells may be of any degree of severity or of any extent, and the paralysis may vary between slight weakness and complete loss of all motor power.

It is, I think, reasonable to suppose that a lesion in the motor tract of the cord may destroy some of the nerve cells of the nucleus of origin of a muscle, while others in the same nucleus may escape, and this might especially be the case if the nucleus of origin is an extensive one. Although the nuclei in the anterior cornua have not yet been mapped out into groups corresponding with the muscles they supply, yet there is evidence to support the view that many of these centres extend for an appreciable distance longitudinally in the cord. Dr. Sherrington, than whom there can be no better authority on this point, in an exhaustive paper on the lumbo-sacral plexus, based on experimental researches in monkeys and other animals clearly takes the view that some at least of the nuclei of origin of muscles in the anterior cornua may occupy an area of considerable extent, and in the plate which accompanies his paper in Vol. xiii. of the *Journal of Physiology*, he represents the nerve supply to many of the muscles of the leg as arising from the cord at two or three separate levels.

If this be so in the human subject, one can readily understand how a muscle might be partly crippled by poliomyelitis, and yet retain a more or less complete degree of voluntary power through the support of such of its ganglion cells as might happen to survive. There is also the possibility of neighbouring cells taking up the work of those destroyed. The object of electrical treatment would then be to stimulate and develop any surviving fibres, and, if possible, to make them numerous enough and strong enough to form an useful muscle.

Duchenne long ago pointed out that a muscle crippled by infantile paralysis may still contain a few living functional muscle fibres, and that these may easily be overlooked in an ordinary electrical examination of the muscle, but that they may be successfully cultivated by persevering treatment. There is no doubt that cases admitting of similar interpretation do occur; for example, I have seen a quite respectable sized mass of calf-muscle develop in a limb which, for two years at least, had shown no trace of electrical reaction of any sort in that region, and the same in other muscles, notably in a deltoid muscle which, after remaining for nearly three years completely atrophied as the remnant of an extensive paralysis of the upper arm, is now beginning to grow, and to show faint contractions of normal quality to the induction coil.

A muscle which is greatly atrophied, and in large part the seat of fatty degeneration, may still contain a fair number of active muscle fibres scattered in it, and these may remain in a dormant state for several years, and yet be capable of great development if eventually they come under electrical treatment. Duchenne has related several cases of this sort, where treatment commenced as late as four years after the onset of the disease gave most favourable results.

Through the kindness of Mr. Langton I have had an opportunity of testing and dissecting the muscles in an amputated leg the seat of severe infantile paralysis of old standing. The age of the patient was 20 years, and the limb had been diseased from childhood. The muscles of the leg were all extremely atrophied, degenerated, and fatty; in fact, the calf was almost indistinguishable from adipose tissue, but still contained a sufficient number of normal muscle fibres to make it contract fairly briskly to the induction coil current. The other muscles of the limb, though in a state of advanced atrophy, all contained fibres which were able to respond either to the induction coil or to the galvanic current.

The majority of the cases of infantile paralysis with which I have had to do are those with paralysis of the leg muscles, and in many of them a year, or two years or more, has elapsed since the incidence of the disease. Apparently the lower limbs are much more commonly affected than the upper, but this may be partly accounted for by the sources from which the electrical department at St. Bartholomew's Hospital is supplied, for a large number of cases are sent over by Mr. Walsham from the Orthopædic Department, having been brought there in the first instance because of some lameness. Among the poor it often happens that the paralysis is overlooked or neglected until the time has come for the child to begin to walk, and then, or even later, an effort is made by the parents, and the child is brought for medical advice. I mention this in order to show that these cases have, many of them, been left to improve spontaneously before coming under treatment, and in fact that they are cases of old standing, who have undergone what is called expectant treatment without recovery. The material, then, is not of the most favourable kind, and some of them are in a sorry plight, but all the cases that come, however hopeless they may look, are put under treatment, and all improve, some only a little, others very much.

Among the cases two different types exist. In one the muscles are thin, but they present reactions which, though weak, are normal in quality, both to the induction coil and to the constant battery. In the other group the muscles are paralysed, atrophied, and show only a reaction of degeneration, or even no reactions at all.

It cannot fairly be said of the first group that they will recover simultaneously; their very presence in the department shows that they have failed to do so. Under treatment they usually begin to progress from the first, and as a rule do

* Paper read before the Medical Society of London, March 5th, 1894.

very well; but even so their improvement is often a gradual one, requiring treatment for months. When these cases have ceased attending for a time, and they are again brought back, the history is usually that the progress of the muscles went on for a time and then ceased, therefore they are brought again for further treatment; others do better and recover completely from the first, but the affected limb commonly remains rather thinner and rather weaker than its fellow.

I do not wish to imply that no muscle paralysed by poliomyelitis recovers spontaneously; it is certain that many do so recover, but rather that there are many cases which remain in a state of very imperfect recovery, even though their electrical reactions are normal, and that these derive immediate benefit from systematic electrical treatment.

With cases of the second class, namely, those with great atrophy, paralysis, and the reaction of degeneration, it is also too sweeping a statement to say that they are incurable, and that electricity can do nothing for them. Electrical reactions do return in muscles which before showed no signs of contraction, and this I have seen a fair number of times; in particular I would mention a patient brought to the hospital at the age of 3, with a history of paralysis having come on at the age of 4½ months. She had been an in-patient for four months at Queen's Square, and while there recovered power in her arms and back, which had been powerless. Treatment commenced in June, 1891. No reactions then in any muscles of either leg, extreme wasting, tendency to talipes equinus in left foot. Patient quite unable to stand. The improvement has been very slow, the attendance very regular; at present her legs show reactions to the induction coil in very nearly all the muscles on both sides, and she can walk, though in a rather awkward manner. This is due to the state of one quadriceps extensor muscle, which continues very thin and weak. This child, although still very feeble in her legs, has made and is still making progress, and is a clear instance of the return of voluntary power and normal electrical reactions in muscles which at one time seemed to have fallen into the last degree of atrophy and paralysis.

Two similar cases of which I have notes are the following:—

F. P., æt. 5, paralysis for four years, return of normal reactions after six weeks' treatment.

C. T., æt. 11, paralysis for eight years, return of normal reactions after 18 months' treatment.

The routine treatment adopted at St. Bartholomew's with the infantile paralysis cases is as follows:—At the first visit the muscles are tested, the girth of the affected limb measured, and the voluntary power of the paralysed muscles ascertained, and any faulty attitude of the limb noted. The mother is then told that the child must be brought twice a week to the department for six months at least, for electrical treatment, and she is further told to bathe and manipulate and rub the affected limbs every night for a quarter of an hour in hot water. If irons or other orthopædic appliances are worn the child is to be encouraged to exercise its limbs without them for a little time every night before the evening bath. By impressing upon the mothers the need for patience and perseverance, one is able to ensure their hearty co-operation, and this is the most important factor of all. The electrical treatment of the children is for the most part carried out at the hospital by the mothers themselves, who are shown how to use the electrodes, and quickly learn what is required. A very fair proportion of the total cases settle down into regular attendance. Those who fall away do so usually in the earlier months of treatment, those who remain remain long.

The first signs of improvement are a better circulation in the affected parts, and disappearance of chilblains and sores, and a gradual gain of voluntary power.

The return of electrical reactions comes later, and it is common when all contractility has been lost for the normal reaction to the induction coil to return without an intermediate stage of contraction to galvanism only. This may perhaps be explained by supposing that the few latent normal fibres in the wasted muscle have begun to grow and gain sufficient strength to produce a visible contraction.

The apparatus used:—Both the induction coil and the constant current battery are employed for the electrical treatment. Custom has selected the constant current for the treatment of muscles showing the reaction of degeneration, reserving the induction coil for the less severe cases in which the muscles retain the power of contraction to the currents of the induction coil. This choice of current is probably based on theoretical grounds. It is true that a muscle showing the reaction of degeneration will contract to the constant current only, and in so far as the contraction of the muscle is a good thing for the muscle, the constant current may be better than that of the induction coil; but it is by no means certain that the amount of benefit can be measured by the amount of contraction set up in the muscle. A muscle which is completely cut off from its nucleus of origin will continue to degenerate and waste, however persistently it be made to contract by treatment with the constant current. This matter of the relative advantages or virtues of constant and interrupted current dates from a long way back. Each has been warmly advocated by its partisans, to the exclusion of the other, since the days of Duchenne and of Remak.

But in paralysis any form of electrical application is of value simply as a most convenient way of stimulating the activity of the living tissues of the part under treatment, and, as a matter of fact, even with the constant current of a battery, the stimulation is chiefly obtained when the current is made to vary by interruptions or reversals, or by movements of the electrode over the surface.

The recent investigations of Messrs. Gautier and Larat seem to show clearly that varying currents have a greater stimulating action on the tissues than steady currents, and that the former promote the metabolic activity of the living cells to a very much greater extent than steady currents do, and in practice I have found that the interrupted currents of the induction coil have quite as high a value in the treatment of infantile paralysis as the constant current of a battery.

When the treatment has to be put into the hands of a nurse, the induction coil is the best, because it is more easily managed and kept in order, and the vibrator, with its buzzing sound, serves to show that the apparatus is working, and the strength of the current can be readily gauged by feeling it.

Whenever children are to be treated by electricity, great care must be taken not to frighten them by sudden shocks; the current used must never be so strong as to alarm them or make them cry, and it is important that the contact breaker of the coil shall work very smoothly and evenly. Many coils are defective in the matter of contact breaker; until lately there has been little attention given to it, and any sort of vibrating spring is thought good enough, but there is all the difference in the world between a good and a bad one. The difficult problem of testing a child's muscles without making it cry becomes much easier with a good coil, and a smoothly acting contact breaker working about 40 or 50 times a second. Of all the coils I have tried those of Gaiffe, of Paris, seem to me to be the best.

It is perhaps a little premature to discuss the value of the electrical supply from the house lighting mains, as I have not yet had opportunities of trying it upon cases of infantile paralysis, but from general considerations of the quality of current on the alternating system of supply I am disposed to think that that form of current properly applied through a transformer should be of distinct value in the treatment of infantile paralysis.

When the lower limbs are the seat of the paralysis an improvised electric bath is an excellent method. An ordinary wooden tub or earthenware foot-bath filled with warm water is taken, the electrodes in the form of plates of metal are suspended at the two ends, and the child dressed in a short waistcoat is put into the bath in a sitting position. The current is very well borne in this way, and the whole extent of the paralysed parts comes simultaneously under treatment. This plan can easily be carried out at home by the nurse or mother of the child. The strength of the current is gauged by putting the hands into the tub, one at each end. This plan requires no special knowledge of anatomy, it is efficient and likely to be persevered in, and this question of perseverance over long periods of time is the key to success. Even if only one of the lower limbs be affected, there is no reason why the bath should not be used, and if the sound leg be flexed and drawn up most of the electrical current can be diverted into the affected one.

In conclusion, I give as a summary of the position: It is important in every case of infantile paralysis which has lasted over four weeks to try electrical treatment, continuing it for six months or a year.

It is the exception for a muscle to be so completely destroyed by poliomyelitis as to have no functional fibres left, and great development of these remaining fibres may be gained by persevering stimulation of them.

Where the electrical reactions are reduced to the very lowest flicker, or even entirely abolished, some improvement may be hoped for.

Where the electrical reactions are not altered in quality, it is not good practice to leave the case to take care of itself. Electricity acts only as a stimulating treatment, but it is superior to any mechanical stimulation by rubbing or massage. It may advantageously be combined with these. The form of electrical stimulation to be employed is less important than the need for perseverance.

The induction coil, with or without the bath, is quite easily arranged for use by the mother or nurse of the patient.

THE SCIENTIFIC STUDY OF ARC LAMPS.

By RANKIN KENNEDY.

VII.

The differential coils described in our last article acted directly on two long cores carrying the carbons, and effected the feeding without any intermediate mechanism. The same method is employed in the Byng arc lamp using parallel cores instead of tapered cores, as in the Pilsen lamp. From this it would seem that the taper on the cores is not at all essential, and, in fact it is not; for by properly proportioning the coil and cores, straight parallel cores are quite effective. But such lamps, whether with straight or taper cores, do not meet every requirement in electric arc lamps. It is difficult to make them long-running lamps, and also difficult to make them for alternating currents, otherwise they are first-class lamps for continuous currents and for running up to eight or ten hours at a charge.

The differential coils and cores are most usually applied through one or other of the mechanical devices described in our previous articles for the regulation of the feed, so that short cores are employed, and these move only through about an inch of travel.

Fig. 27 is an example of a lamp with this differential electric regulation. A is the shunt coil, B the main coil; a flexible strap carries a core working into each coil. These cores are $\frac{1}{2}$-inch thick and 2 inches longer than the coils; that is, about 6 inches long. In this lamp the coil, B, has three layers of No. 12 B.W.G., 100 turns of wire, and carries 9 ampères, that is, 900 ampère turns.

For all practical purposes, the power of coils can be compared accurately in ampère turns; that is, the ampères flowing through multiplied by the turns of wire equals ampère turns. Coil B must be somewhat more powerful when 9 ampères are flowing in it, than coil A; when the arc is of proper length, that is when a pressure of 45 volts is on the shunt coil, A, in this lamp the ampère turns on A at 45 volts just balances the ampère turns on B, so that we can calculate the current, and hence the wire suitable for coil A at a pressure = 45 volts.

Between 200 and 300 ohms is the usual resistance for a lamp shunt coil; in the lamp here shown it is 225 ohms, so that the current in the shunt is equal to $\frac{45}{225} = \cdot 2$ ampères, and therefore $\frac{900}{0\cdot 2} = 4{,}500$ turns would be the proper number of turns of wire on the shunt coil. It is obvious a fine wire must be used both for the purpose of getting high resistance, and for the purpose of getting in all these turns on the bobbin; for a bobbin of this size, 4 inches long and $2\frac{3}{4}$ inches outside diameter, No. 32 silk-covered wire, gives the necessary turns and fills the space. This bobbin was found to warm up in practice, so that another had to be substituted of heavier wire, No. 29, and the bobbin had to be lengthened to accommodate this heavier wire, as we had still to get in the number of turns and keep up the resistance. Small shunt bobbins must be wound with fine wire, and invariably heat up. It is a great mistake to make small shunt coils for arc lamps; by making them large they do not take more current, and they remain cool and are not liable to break down so easily as a small coil of very fine wire. A good continuous current shunt coil should be about 250 ohms resistance, and should be wound on a bobbin at least 5 inches long—6 inches would be better. 3,500 feet of No. 30 wire would give the necessary resistance and number of ampère-turns when wound on a bobbin for a half inch core.

The figures here quoted are not in every case applicable; but are given as a guide to the student in forming his ideas as to what the dimensions of arc lamp coils may be. Some lamps do not require the shunt coil to balance the main coil; in these lamps weights or springs are adjusted to partially balance the main coil, so that a weak shunt can be used to do the rest. In these cases, the calculating of a shunt is not of much import so far as ampère-turns is concerned, for the balance can be adjusted by the springs or weights; but still the shunt coil must be large enough to resist the 45 volts without heating.

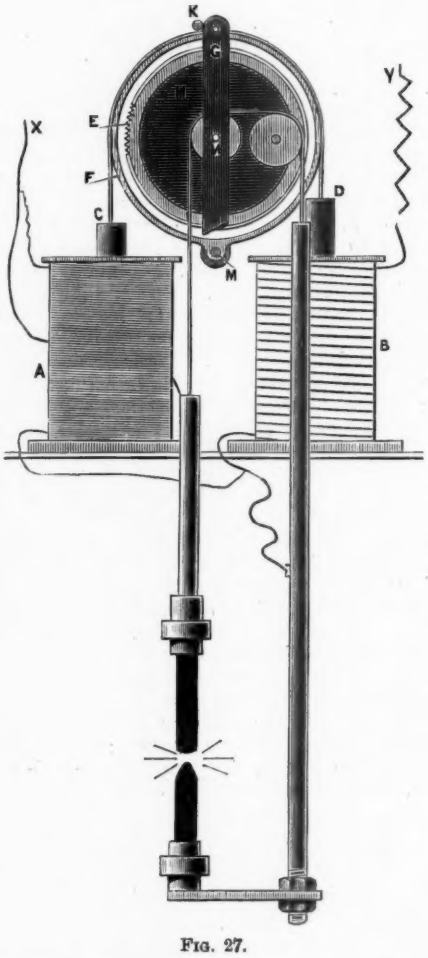


Fig. 27.

In any case, a small coil is an abomination; it is so easily damaged, and as its wire is very fine, it costs a deal for wire and for winding. Nothing is more foolish in lamp designing than for the sake of appearances, or size, or some other fad, to make small bobbins to carry the wires; generally by a little scheming and thought room enough can be made for larger bobbins, and then large wires can be used, running cool, and not easily burnt out.

In the lamp illustrated, the main bobbin pulling down on the core turns the ring, F, on centre, M, until it engages by tooth, E, in wheel, H, which is toothed all round, still pulling down wheel, H, frame, G, and ring, F, all turn on centre, N, thus lifting the carbons apart, and frame, G, recedes from stop, K. As the arc lengthens, the pressure rises on coil, A, which pulls back feeding down the carbons by turning the whole on centre, N, but the further motion of frame, G, is arrested by the stop, K, in a short time; and then the further

feeding takes place by ring, F, rocking on centre, M, and disengaging tooth, E, allowing wheel, H, to slip round one tooth at a time.

This is a step-by-step feed. I shall have occasion to refer to this feed when we come to consider the various feeds of arc lamps. Some young engineers seem to have been taught that there is only one kind of feed, and look upon lamps not having that particular feed as faulty. A little experience will correct that notion in some of them. There is the

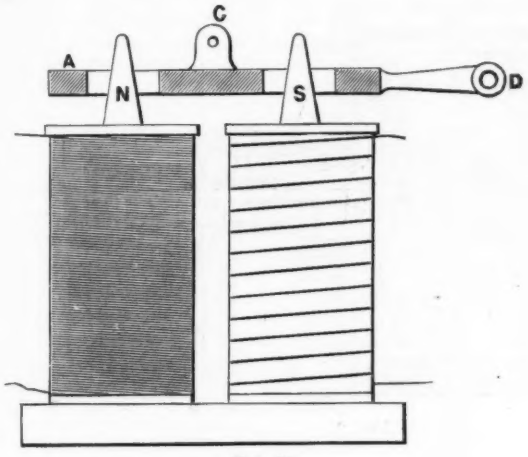


Fig. 28.

continuous feed, much sought after, and sometimes attained in the test room of a factory but never in practice; there is the intermittent feed, which is the common feed, and the step-by-step feed.

The testing of a lamp with one feed is quite a different process to testing a lamp with another feed.

Now, to return to our differential gear again, two electromagnets with fixed cores can be used for differential feeding. The Thomson-Houston lamp has a magnetic feed of this kind. In fig. 28, the poles, N, S, are tapered, and the keeper, A, is movable on joint, C, and has two eyes or holes encircling the poles, so that it can move freely over the poles and work the lamp mechanism from lever, D. It will be clear that the keepers will move one way or other, according as the fine wire or thick wire coils are the stronger.

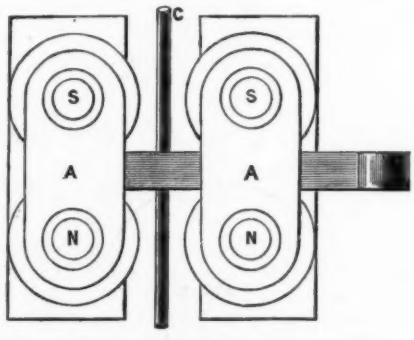


Fig. 29.

In making up this mechanism, it is better to have four coils and two magnets, so that the shunt magnet acts entirely independent of the main magnet. This arrangement is shown in the plan, fig. 29.

MORTON'S STEAM TURBINES.

The steam turbine seems to be attracting very considerable attention at present, judging from the numerous patents being applied for, chiefly by electrical engineers.

The Parsons turbine is an acknowledged success and is doing good work, and we recently described the De Laval turbine, which also seems to succeed. The Morton steam turbine was the subject of a paper read by Mr. Morton before the Glasgow Society of Engineers and Shipbuilders. It is based on the reaction principle, if we accept the author's statement, but the fixed curved blades look very like guide blades, and according to Rankine a reaction turbine is a turbine without guide blades. We rather think if the nozzles were fixed, and these curved blades allowed to revolve, the results might be better. The author admits that the action of the jets against the blades is equal, and opposite to, the reaction in the nozzles. If that is so, why not fix the nozzles and revolve the blades, and thereby make a simpler engine without all the packing rings and making the lighter part the moving part. However that may be, this turbine is a valuable contribution to the class, and we give the following extracts from the paper read upon it by the inventor himself, with sections of the turbine.

We may say that many years ago the steam turbine question was well thrashed out by engineers, and the patent records contain scores of ideas on the subject, some worked out and some only proposals. The paper is devoted chiefly to a description of some improvements recently made on the oldest engine we have any account of in history, viz., the revolving eolipile of the ancients, described by Hero, of Alexandria, in the second century, B.C.

This improved engine, and dynamos to suit, were made, and the drawings, figs. 1 and 2, represent it. Fig. 1 is an end section, showing on the left of the vertical central line one-half of the first or outward flow wheel, and on the right of the same line one-half of the inward flow wheel.

The casing, A, of this engine has only one simple compartment, fig. 2, the casing being one casting, with two end covers bolted thereto, enclosing two distinct and separate wheels. The first wheel, B, has three rings, 1, 2, and 3, of outward flow nozzles of different diameters. The first, or smallest ring, is $9\frac{1}{2}$ inches, the second $12\frac{1}{4}$ inches, and the third 15 inches diameter, thus forming annular spaces between the rings. The second wheel, B, has two rings of inward flow nozzles, 4 and 5. The larger ring is 15 inches, and the second, or inner, $12\frac{1}{4}$ inches diameter, thus forming an annular space between the two rings, into which spaces the curved projections, F and F^1, are fitted. Both wheels are mounted on the same shaft, D, and enclosed in a single compartment casing, A. The higher pressure steam enters the first wheel, B, by an annular opening around the shaft, D, as shown by the arrows (fig. 2), and travels outwards through the first ring of nozzles into the first annular space between the first and second rings, and flows out through the nozzles of the second ring into the second annular space, and from thence outwards through the third ring of nozzles into the casing, A, which is common to both wheels.

The steam returns from the casing, A, flowing inwards, first through the larger ring of nozzles, 4, into the annular space between the rings, and in through the second ring of nozzles, 5, towards the centre of the inward flow wheel, B^1, thence through the exhaust annular opening around the shaft, and by the branch to the condenser.

At each ring of nozzles the combined area of these openings increase as the steam becomes reduced in pressure. The first ring of the series has eight, $\frac{1}{12}$-inch by $\frac{1}{2}$-inch, and the last ring 10 curved nozzles, $\frac{1}{8}$th-inch by 1-inch, and there are only five stages of expansion in this engine. The steam issuing from the curved nozzles in a tangential direction tends to circulate in a contrary direction to that in which the wheels may be revolving, to prevent which a series of curved projections, E, are cast or fixed on the interior of the casing, A, for the outward flow current, and another series, F, are cast on or fixed to centrally fixed discs, H, in the interior of both the outward and inward flow wheels, so as to arrest the outward and inward flow currents. These projections are more clearly shown by the enlarged sections, figs. 3 and 4. Fig. 3 is an enlarged section of a segment of the casing, A, enclosing a segment of the outward flow side of the wheel. The curved projections, E, are shown cast on the interior of the casing, A, to prevent circulation therein, and fig. 4 is a similar segment of the casing, A, enclosing and showing in section a segment of the inward flow side of the wheel, B. The curved projections, F, in the interior of the inward flow side are cast or fixed on a central

stationary disc, H, supported by its central trunion passing out through the wheel, and fixed in the partitions.

To describe the numerous experiments, with different forms of nozzles, before the form shown on the drawings was adopted, would require a paper on that subject alone; but the two experimental apparatus shown by figs. 5 and 6 are so important to this paper that they cannot well be left out. Fig. 5 is a full size section of an apparatus constructed with a central cylindrical tube $\frac{3}{16}$ths of an inch wide at the narrowest part, or throat, tapering to $\frac{5}{8}$ths of an inch at the mouth. The tube is 10 inches long, and has three shall branches, 1, 2, and 3, communicating, by very small holes, with the interior of the tapered tube. To these branches, 1, 2, and 3, three bent glass tubes are coupled by short pieces of India-rubber tube, and these glass tubes reach down to near the bottom of a dish of mercury, C.

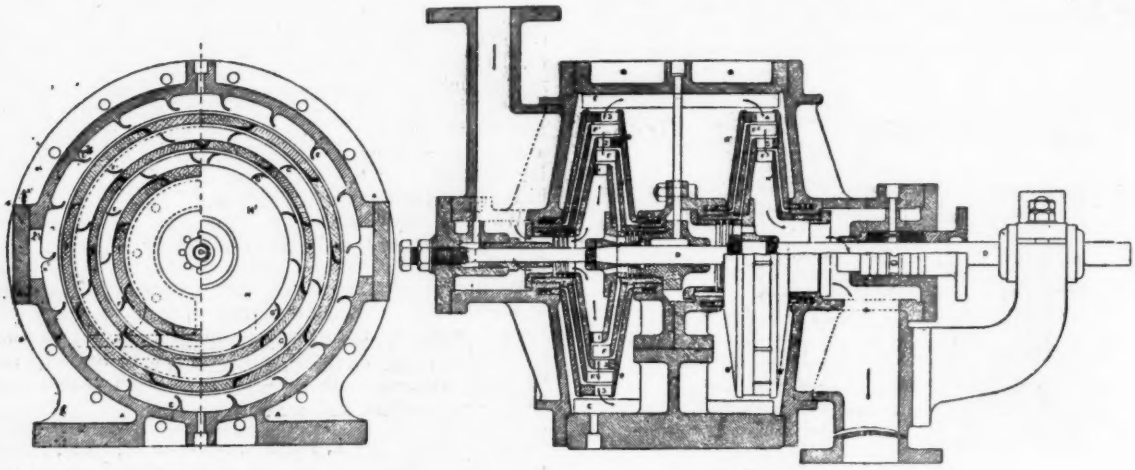


Fig. 1. Fig. 2.

The apparatus is bolted on to a branch steam pipe, A, with the throat end next the supply steam branch, all as shown by fig. 5, ready for experiment. On opening the stop valve so as to admit steam to the supply branch, A, it flows through the throat of the apparatus, and is freely delivered into the atmosphere at the mouth or wider end, and the effect is shown by the mercury rising in the glass tubes connected with the branches 1, 2 and 3. The mercury in No. 1 rises highest, that in No. 2 next, and that in No. 3 scarcely any, showing that a partial vacuum is maintained throughout the whole length of the tapered discharge tube. In case the naked tube should in any way affect the experiment, it was enclosed within a parallel brass tube and soldered, so as to leave a free space all round. Steam was admitted into this annular space by the branch, B, so that the central tapered tube was encased with steam of a higher temperature than that passing through it; but on again performing the experiment, practically the same result was obtained, viz., a partial vacuum throughout the whole interior of the tapered tube, the vacuum being greatest near the throat.

Another experimental apparatus (fig. 6) was made in form of a bent tube, tapering from $\frac{1}{16}$th-inch by $\frac{3}{4}$-inch at the throat to $\frac{7}{16}$ths-inch by $\frac{3}{4}$-inch at the mouth, encased in a larger tube, and soldered steam tight. The branches, 1, 2 and 3, communicate with the mercury dish, C, as in the previously described experiment, and those branches, 4 and 5, with pressure gauges. The acting steam is admitted by the branch, A, and the encased steam by the branch, B.

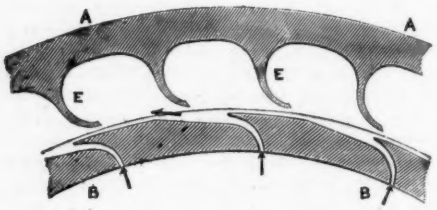


Fig. 3.

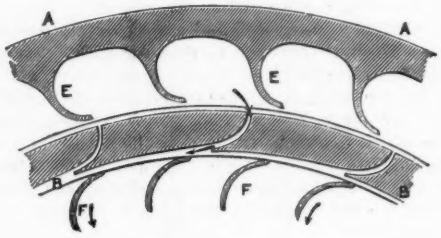


Fig. 4.

On performing the experiment, it was found that a partial vacuum was maintained all along the lower, or convex side, and a partial pressure all along the upper, or concave side, of the encased bent tube; there is therefore a partial pressure on the concave side, and a partial vacuum on the convex side of a tapering bent tube at the same instant of time when high pressure steam passes freely through it into the atmosphere, and this is the form of nozzle which has been adopted, and shown more clearly on the enlarged scale drawing, figs. 3 and 4.

It would seem from those experiments that steam issuing freely from an orifice, without admixture of air or other

vapour by induction, expands very little, if any, latterly when free to expand on end, thus behaving very similar to that of liquids—such as water under the same circumstances.

In concluding this paper, a few remarks as to the efficiency and uses of this reaction engine would be useful. The engine, coupled direct with the dynamo (figs. 1 and 2), has only two compound wheels, and when both were in place, with a given weight of steam, this engine developed 11·0 electric or brake horse-power, and when the low pressure wheel was removed, and the high pressure wheel alone in place, the duty, with the same weight of steam, fell off to

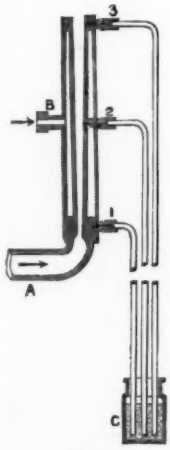


Fig. 5.

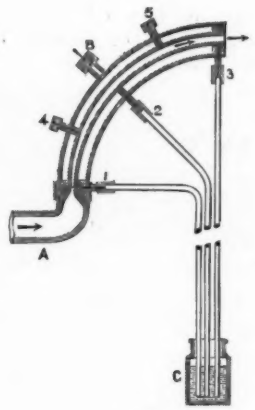


Fig. 6.

6·5 B.H.P.; and with the high pressure wheel removed, and the low pressure wheel replaced, 4·5 B.H.P. was given, thus agreeing with the experiment when both wheels were in place, 6·5 + 4·5 = 11·0 B.H.P.

In March last, Dr. Archibald Barr, and Mr. Henry A. Mavor, of the firm of Messrs. Mavor & Coulson, electrical engineers, made a joint series of experiments on the engine represented by figs. 1 and 2, and from their report, the duty—with 78 lbs. per square inch, above atmosphere, initial steam; 20 inches vacuum; the engine developing 10·16 B.H.P.—required 87 lbs. of steam per B.H.P. per hour, with feed water at the low temperature of 40·3° F.

ELECTRICITY SUPPLY STATIONS.

No. 16.—Brussels Municipal Station.

The electric lighting of the town of Brussels has been under the consideration of the Municipal Council for many years. The burning question of whether a concession should be granted to a company or the enterprise be retained by the municipality in its own hands, after having been much discussed, was eventually decided in favour of the latter.

Accordingly, in April, 1891, a general specification was drawn up, and tenders were invited from all quarters for a complete scheme of private and public lighting, without specifying the system to be used, but requiring that full details of the system should be given, as well as the estimated working expenses, the contractor selected to carry out the work, being required to undertake the working of the station for two years, and to submit to heavy fines in the event of the actual working costs during this period exceeding their estimated costs.

Of the schemes submitted, including both alternating current and continuous current plant, a three-wire low-pressure distribution—worked in conjunction with accumulators—was selected; and on December 5th, 1892, the India-Rubber, Gutta-Percha, and Telegraph Works Company, of Silvertown and Persan Beaumont, ably represented in Belgium by Mr. Boty, was entrusted with the execution of the contract, on the understanding that, as far as possible, all machinery, &c., should be constructed in Belgium, and that the whole of the contract should be completed in eight months after the site for the station should have been placed at their disposal. The site selected for the central station was that occupied by the old church of Ste. Catherine, Rue Melsens, in the lower part of the town, adjoining the main boulevard; and this ground, with the church and buildings upon it, was handed over to the company on February 13th, 1893, the work of demolition being commenced on the same day.

This work, together with that for the excavations for foundations—which necessitated the removal of about 7,000 cube yards of earth, and the clearing away of the massive foundations of the old church—occupied a period of about ten weeks; and, eventually, in the middle of May, the construction of the new buildings was commenced by the contractor, M. La Barre, acting under the instructions of M. Devreux, the architect, and of the company's resident engineer, Mr. Stuart A. Russell.

The Works.

The building includes a boiler and machine room on the ground floor; and, on the first floor, a battery room, repairing shop and stores—over the machine room—whilst the coal store, water purifiers, and tanks, are placed over the boiler room.

The chimney, 190 feet high, and 8 feet 4 inches internal diameter at the top, occupies an angle formed by the boiler and machine rooms, and is built of radial bricks and carried on a brick and concrete foundation 15 feet deep.

In the same block of buildings, but occupying a strip of land separating the station proper from the Rue Melsens, are the offices necessary for the administration, and the testing rooms.

The coal store, of 200 tons capacity, being on the first floor, an electric lift has been constructed to convey the fuel to it. And it is proposed to construct a small tramway to the Willebrocck canal, to facilitate the discharge of fuel brought by water. From the coal store, the fuel is conveyed by suitable shoots to the stoking space; these shoots being telescopic, so that they may be lowered to avoid the making of dust when coal is being discharged, and raised out of the way at other times.

The water supply, both for condensation and feed, is obtained from the Willebrocck canal—which is distant about 350 yards, two 18-inch pipes having been laid with a slight fall from the canal to a small reservoir under the machine room—to which are brought the suction pipes of the condenser pumps. A certain quantity of the condensing water, according to requirements, is pumped up to the water purifier, from which it is discharged into the main tanks. The water purifier, of the Dervaux type, is capable of dealing with about 2,500 gallons of water per hour, and the capacity of the main tanks (two in number) is about 22,500 gallons.

When complete, the station will contain plant of 3,000 I.H.P., the unit adopted being a 500 H.P. engine, driving two 250 H.P. dynamos.

Provision is made for placing six such units, one being a reserve; but as the specification of the municipality stipulated that the machinery should be capable of working at 25 per cent. in excess of its normal full load, the ultimate maximum working capacity of the station may be taken as 3,000 H.P., not including reserve.

The Plant.

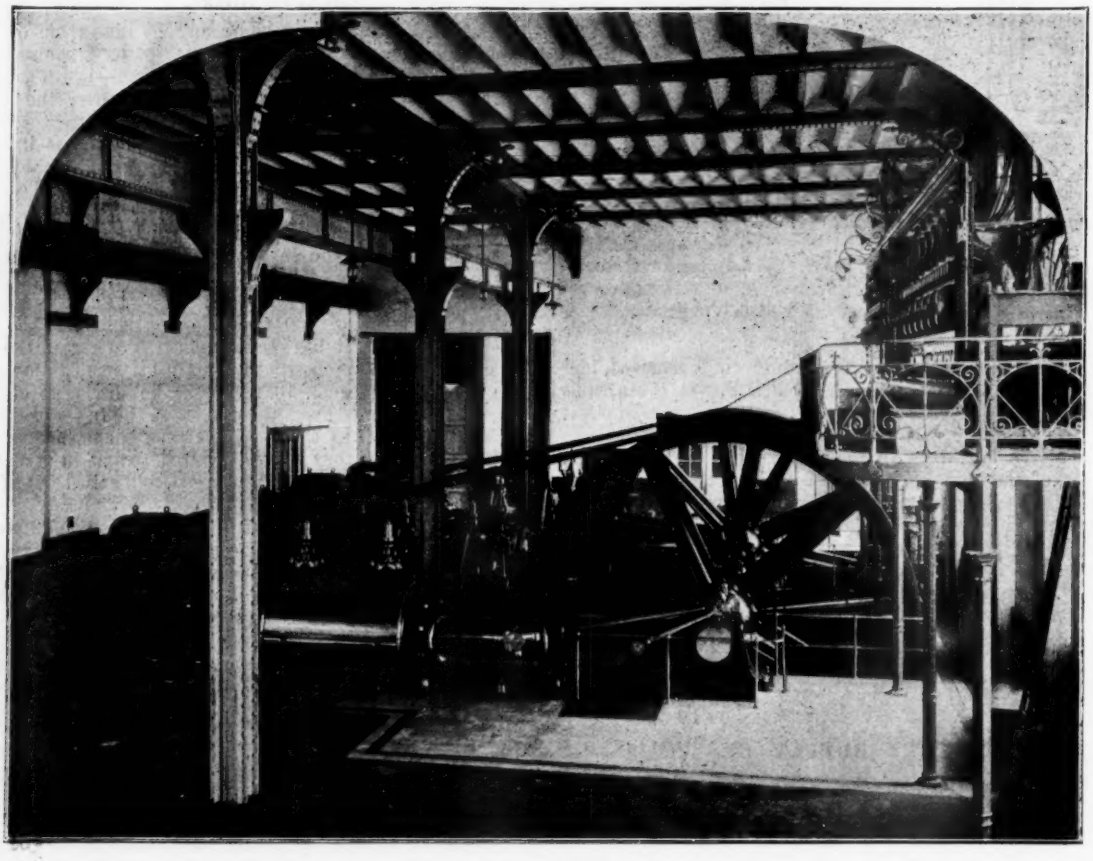
The present plant consists of three Babcock and Wilcox boilers, constructed by Brouhon, of Liege, each of 2,440 square feet heating surface, and capable of evaporating 7,500 lbs. of water per hour with a good quality of Belgian coal. The boilers are of the usual type, working at 9 atmospheres, pressure, but with specially large grate surface (56 square feet), to allow of coke being used for firing instead of coal. These boilers are fed by one Worthington pump, another being held in reserve, each pump capable of supplying to the boilers 2,600 gallons of water per hour, the water being drawn from a small cistern at the back of the boilers, to which the water descends from the main tanks, the supply being regulated by a ball cock. This cistern can also be supplied with water from the town mains, in case of an accident preventing the use of the supply from the canal. The feed water passes from the pumps through a Green's

economiser, of which two have been provided, each of 2,160 square feet heating surface, and thence to the boilers. All the feed piping is double, and is so arranged that any boiler can be fed by either pump, the feed water passing through the economiser, or in case of repairs to this apparatus, directly to the boiler. All the steam piping is also double, two main pipes running across the tops of the boilers, being carried through into the machine room, and running in a subway the whole length of it. Each boiler is connected to each of the two main pipes by a branch provided with a stop valve, and a branch is taken from each main pipe to each engine.

The machine room, which is 120 feet × 52 feet × 28 feet, contains the engines, dynamos and switchboard, and is fitted with a traveller running its whole length, and capable of lifting 15 tons. To fulfil the very stringent conditions as to the absence of vibration, a block of concrete, about 6 feet thick, has been laid as a sub-foundation, which extends over the whole surface of the engine room, but is entirely independent of, and isolated from, the foundations of the building, and on this block the brickwork foundations for the engines and dynamos have been built, also separated from the walls of the building. The engines, two in number, are of the Sulzer horizontal, side by side, compound condensing type, with adjustable cut-off, supplied by Carel Frères, of Gand.

The low pressure cylinders are 40 inches diameter, and the high pressure cylinders 26 inches diameter, the length of stroke being 4 feet, and the speed capable of variation between 62 and 75 revolutions per minute, the highest speed being necessary for the charging of the accumulators. Each engine is fitted with two nine-groove fly driving wheels, 20 feet in diameter, and weighing 20 tons. The most economical load for each machine is 400 H.P., so that for a range of 250 to 625 H.P., the consumption of steam per brake horse-power is small, and a good efficiency should be assured on the average working load throughout the year. For engines of a similar type, constructed by the same firm, tests carried out by the Association for the supervision of boilers give the following results: On an engine constructed for a normal output of 500 H.P. at 60 revolutions, when working at 138 H.P. with 5·7 atmospheres' pressure, the steam consumption on a test of eight hours was rather less than 13 lbs. steam per indicated horse-power hour. With a similar type engine, 400 H.P. size, working at 5·8 atmospheres and indicating 250 H.P., the steam consumption was 13·1 lbs. The same engine, tested 5½ years later, giving a consumption of rather less than 14 lbs., working at 6·9 atmospheres and indicating 330 H.P.

The engines are erected side by side with the cylinders at right angles to the length of the hall, and each engine drives two dynamos by means of 18 1⅝-inch ropes. The dynamos are of the four-pole type, shunt wound, with drum armatures, running at 300 to 360 revolutions per minute, with an output of 145 kilowatts as the normal full load, but capable of working up to 180 kilowatts for a continuous run of 12 hours, without overheating or sparking at the brushes. These dynamos are carried on slide rails, to allow of the tightening of the rope drive as required, and are fitted with self-oiling bearings. They have been constructed, as also the switchboard, by the Société Electricité et Hydraulique to designs and plans supplied by the Silvertown Company.



View of Engines.

The Switching Arrangements.

The switchboard is fitted for six pairs of dynamos, a battery of accumulators, and 24 feeders, and is formed by a series of black marble panels carried in a wrought-iron frame, the whole being mounted on a gallery fixed against one of the long walls of the engine room, at a height of about 14 feet above the floor, so that the attendants have an uninterrupted view of all the machines. The general scheme of connection of the switchboard is as follows: each set of connections being the same for each pair of dynamos.

The + pole of No. 1 dynamo is connected permanently to the − pole of dynamo No. 2, and both are connected by a cable and a fusible cut-out to the neutral omnibus bar of the switchboard. The − pole of No. 1 dynamo is connected

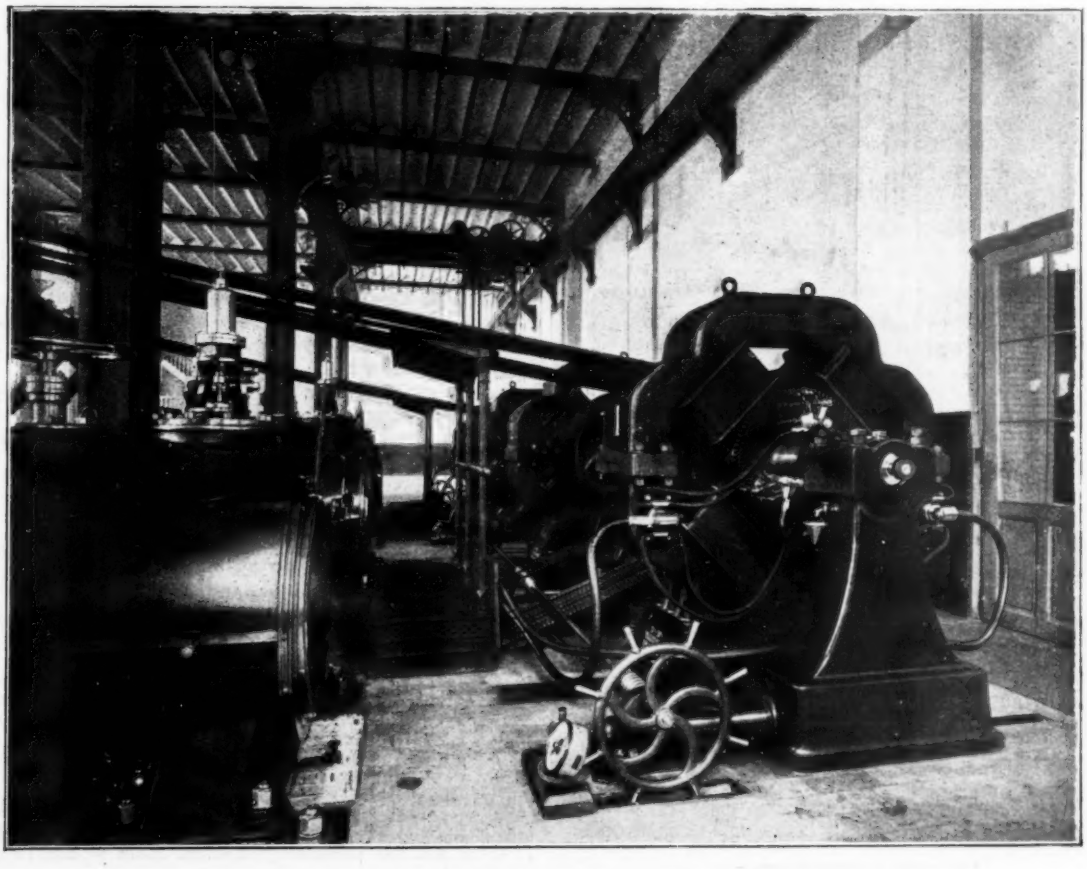
through a fusible cut-out and an ampèremeter to the fixed terminal of a two-way switch, by means of which the circuit can be made either on to the charging circuit of the accumulators, or on to the negative omnibus bar. The + pole of No. 2 dynamo is connected in the same way to the accumulators or positive omnibus bar.

The exciting circuit of the dynamo is arranged as follows: The + terminal of the shunt on dynamo No. 1, and the negative of No. 2 dynamo, are permanently connected to the corresponding main dynamo terminals, and therefore to the neutral omnibus bar on the switchboard. The negative terminal of the shunt on dynamo No. 1 is connected to a switch fixed on the dynamo through which the circuit is connected to the negative omnibus bar, and adjustable resistance fixed on the switchboard being interposed to permit of variation in the exciting current. The + terminal of No. 2 dynamo is connected in the same way to the + omnibus bar on the switchboard. The shunt circuit switches on the dynamos are specially arranged to close the circuit of the contacts, to allow of separate adjustments of ½-volt at full load.

The centre panels of the switchboard carry the registering ammeters, automatic switches, battery regulators, &c., for connecting up the accumulators. Twenty-six cells at the positive end of the battery, and the same number at the negative end, are connected to regulator switches; and the middle terminal of the battery is connected to the neutral omnibus bar, thus allowing of the number of accumulators in use to be varied as required. The discharge side of each regulator is connected through a registering ammeter, a switch and fusible cut-out to the corresponding omnibus bar, and the charge side of each regulator through a registering ammeter and automatic switch to the battery contact of the two-way dynamo switches.

The Accumulators.

The accumulators of the Julien type are 140 in number, forming a double battery of 70 cells. Each cell is capable of



View of Dynamos.

shunt on that of an auxiliary resistance at the moment of rupture, to diminish the sparking and strains on the insulation caused by the E.M.F. due to self-induction on breaking the circuit.

For the main feeder circuits, 24 in number, each + feeder is connected through a separate adjustable main resistance and fusible cut-out with the + omnibus bar, the − feeder being connected in the same way to the − omnibus bar, the intermediate feeder being connected directly to the intermediate omnibus bar. To each distributing centre is led a three-core potential cable conductor, 7/20 L.S.G., connected at one end to the three main cables in the distributing box at the "centre," and the other ends to a pair of voltmeters mounted on the switchboard, to indicate the pressure between the + feeder and the intermediate, as also between the − feeder and the intermediate, the pressure being kept constant on each side of the intermediate cable by varying the absorbing resistances in the main feeder circuits. The main resistance is of platinoid strip and fitted with

giving a normal discharge of 350 ampères for 10 hours; and, in case of necessity, the discharge may, for a short time, be carried up to 1,400 ampères without undue deterioration. The cases are of alloy of lead and antimony. The plates are widely separated, and ample space is left at the bottom for all material that may become detached during work, the total weight of the battery being 80 tons.

The Mains.

For the three-wire distribution, each cable is drawn into a separate cast-iron pipe, with the exception of the potential cable, which is drawn into the same pipe as the intermediate cable. All the cables are continuously insulated, all joints being vulcanised. The conductors are of high conductivity copper, 100 per cent. Matthiesen's standard, tinned and insulated pure, then vulcanising India-rubber taped over all, and the whole vulcanised together, strongly braided flax and covered preservative compound, the insulation resistance being 1,500 megohms per mile, tested in water at 60°

Fah. after 24 hours' immersion and one minute's electrification.

Remarks on the System.

The whole plant was completed and in working order by October 11th, or two days before the date fixed by the contract. The speed at which the work was executed may be further estimated from the fact that although the definite plan for the canalisation was only approved of by the middle of June, more than 55 miles of pipes were laid and 26 miles of cable, including a large quantity of 1-inch and 1¼-inch section conductor, was manufactured in England, delivered, and laid before the opening of the station, the canalisation work being carried out by Mr. Daubeny, assistant engineer to Mr. Russell.

The plant and canalisation have been duly examined and approved of by the experts appointed for that purpose. The station was formally inaugurated by the Bourgmestre and Echevins of Brussels on November 9th, since which time it has been giving a continuous night and day service to the complete satisfaction of the town.

In spite of the rapidity with which the work had been carried out, the solid construction of the buildings, and the simple but complete establishment of the station, show that durability and efficiency are in no way sacrificed to speed in completion; and at the lunch following the inauguration,

Accumulator Room.

the India-Rubber Company received the hearty congratulations of its guests on the success of the undertaking, and the skill and energy displayed by the company's representatives, Messrs. Gray, Boty, and Russell.

It is to be hoped that this, the first cental station erected by an English firm in Belgium, may be shortly followed by others with equal success.

CORRESPONDENCE.

"Science Siftings."

You have certainly criticised my poor remarks in *Science Siftings* very severely; but I think that for a general and condensed account, intended for those who are absolutely ignorant on the subject, my remarks were not far wrong. Perhaps I did not make it clear that when I speak of available current, I mean the amount or strength which is efficient in physiological action upon the tissues beneath the human skin. You advise me to try the experiment of passing the current from a number of cells through a galvanometer, and compare it with that from a single large cell. I am quite aware that the internal resistance is not a negligible quantity, but in comparison with the enormous resistance we have to deal with in the human skin, it is a negligible matter. I might ask you to try an experiment, also: pass the current from one large cell through your head, and then that from several smaller ones, with a milliampère meter in circuit; surely your galvanometer and your head will tell you that the structures below the skin are getting more current in the latter case?

I know that it is so as a fact. May I put it in the form of an example? Thus, assuming for the percutaneous application of the current in a given case the internal resistance is 8, the external 200, then—

$$\text{for one element } C = \frac{E}{R + r} = \frac{1}{8 + 200} = \frac{1}{200}$$

$$\text{for two elements } C = \frac{2E}{2R + r} = \frac{2}{16 + 200} = \frac{2}{216} = \frac{1}{108}$$

So that with an external resistance enormously greater than the internal, we do nearly double the current by doubling the number of cells; if the external resistance is comparatively slight, of course this would not hold. In electro-therapeutics we couple many cells in series; but for galvano-cautery, where the external resistance is small, we connect parallel. You next crush me anent the unit of electromotive force. I am probably not up to date, but had thought that at the International Congress of Electricians in 1881, at Paris, the Daniell cell was selected as the unit of electromotive force, tension, or potential, and was named 1 volt. I should be glad to be set right if I am wrong. You surely did not notice this point because of an error, perhaps a slip of my own, perhaps a printer's fault, I mean spelling Daniell with one l?

My general demonstration of the minuteness of current obtainable from the little bits of copper and zinc usually sold in electric belts, seems to have appeared quite a proof of my absolute ignorance of the matter; but, Sir, I should be greatly surprised if you could find any appreciable physiological effect from a current of much less than a milliampère, reduced by the attempt to pass it through a resistance of over 1,000 ohms, surely I am within the facts when I say that the result would be to reduce the current in the deep structures of the body to practically nil?

You object to the wide limits I place upon the statement of the resistance of the human skin; I can still insist that this resistance is so great and so variable, that no nearer general estimate can be given of it than the "lump of chalk" one which I have mentioned.

Experimenting with the little bits of metal in a belt, the current (such as it is) ceases to flow after a minute or so, and the metals are, I presume, polarised, since by polishing them the current resumes its flow; why should my statement of these facts elicit your severe italics?

Heretic, M.D.

A Strange Tale of a Motor.

I have read it many times over and cannot see the joke. May I ask a few questions in connection with this holding up to ridicule of that innocent letter in the *Coatbridge Express*?

Search lights: now, do they not use them at sea to detect hostile ships at night? And in a street lighted by electricity is there not less probability of street robbery than in one imperfectly lighted by gas?

A dynamo gives electricity and is driven by a steam engine, which is, I believe, a mechanical appliance, and is a transformer of chemical into mechanical energy. Why is the statement absurd that a dynamo converts mechanical into electrical energy?

What cheaper method of producing electric currents exists than the dynamo?

Cannot electro-motors be purchased ready-made (I once purchased one)? Are all those advertisements of motors for sale simply practical jokes? When the editor of the Electrical Review prints such advertisements is it a subtle (Scotch) joke?

The Coatbridge paper states that electro-motors can be fixed in almost any position, and the electrical critic laughs this to scorn; why?

The electro-motor is stated to be *completely* at rest when not working; meaning, as the critic well knew, that it does not have boilers, &c., to wear out, and does not consume fuel when not at work. If the motive power for the town supply be cheap water power, this characteristic of the electro-motor is a good one; then why ridicule the statement?

Would the writer of the criticism prefer his own female relatives to work in a hot, stifling, dusty room, such as are too many rooms in factories where the machines are worked by steam engines, rather than in a factory where small motors are provided with the usual switches? The statement that these switches exist, and can be applied by the feet, is taken as a great joke by the critic.

Are electro-motors apt to be hot, and, if not, what is the matter with the expression "practically cold"?

The slip, or misprint, resulting in the word "maximum" being printed in place of "minimum," and the error of "hitched" for "switched" are really too small for the attention of the ELECTRICAL REVIEW, and I am surprised that they were thought worthy of ridicule.

The impression given to a reader not versed in electrical science by this letter, is that the critic wishes to decry electricity as a motive power and means of lighting. The letter in the Coatbridge paper was merely a popular statement of facts, which are substantially accurately recorded. No reader of that paper would have cared to read a detailed and technical account of the principles and practice of the dynamo, which would be as useful as Egyptian hieroglyphics to the majority. The wise men amongst electricians will do nothing to advance the popular knowledge of science if, in an influential journal, all popular and non-technical statements are thus held up to ridicule; if they are inaccurate or misleading, by all means put us right, but if, like the one in question, they are substantially correct, why try to destroy them?

There is a hint of bitterness and sarcasm about this criticism in the REVIEW, which is to be regretted. I fancy that the writer must have been suffering under some irritation; something really irritating I mean, such as the cook having given notice, or the button at the back of his shirt collar coming off.

Gerard Smith, M.R.C.S.

The Heilmann Locomotive.

I must again trespass on your space with reference to the above somewhat worn topic, though this time with as much approval as criticism of your remarks upon it. In the article published in last week's ELECTRICAL REVIEW upon the Heilmann contrivance from an electrical point of view, the conditions and laws which govern the use of electric motors in general for traction work are very clearly and concisely put; and I for one feel grateful to see the facts set out in proper shape. Only those who attempt practical results in electric traction work can appreciate the difficulties in the way—the various opposing conditions which are, as far as possible, to be reconciled. As an instance I may mention a proposed locomotive on which I lately spent some time in contriving the best arrangement of motors, &c., and in which an output of 500 H.P. was desired, with a limit of speed to 10 miles per hour, and engine weight to 40 tons.

I think, however, you hardly do justice to the capacity of motors for operation in series, when starting, and in parallel when the normal speed is attained; more especially as regards the Heilmann locomotive. This has eight motors, which allow of some considerable amount of grouping in order to reduce the starting current in each machine. Of course, I admit that this does not improve the generating efficiency, though it may do so with that of the conversion in the motors.

A high speed service is, however, essentially one of few stops, and I should look upon it as a primary condition to ensure constant speed throughout, if and where possible after once starting. Surely no one would propose to employ a system like the Heilmann for a tramway service!

Your statement that steam engines are prepared to go up as far in speed as any electro-motor, I should like to simply traverse direct; such is not the case, at least so far as reciprocating steam engines are concerned. Some interesting facts and data in this connection are given in a paper read lately before the Western Railway Club, at Chicago, by Mr. C. H. Quereau, and published in the railway papers. However, I do not wish to be over critical of your remarks as they contain so much valuable substance in small compass, worthy of being digested by every electrical engineer interested in traction developments. Your leading article of December 1st last gives, however, a much more hopeful, if not rosy outlook for electric traction; so I will take that as your creed, and this present article as being a little soured by the defects of Heilmann.

Frank B. Lea.

Balancing in a Three-Wire System.

Re the discussion on the balancing of the three-wire station, I beg to submit the following:—

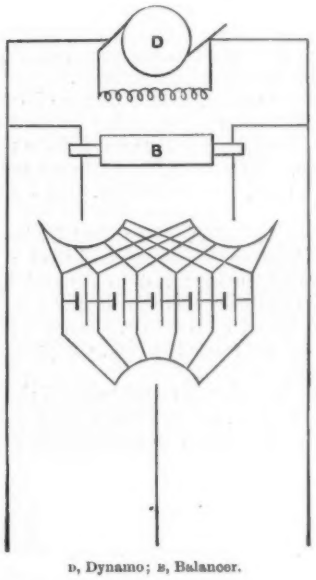
The principal drawback to the arrangement proposed by Mr. Edgcumbe, is the difficulty which would be experienced in the event of a wide difference of charge between the two halves of the battery.

Of course the battery current could always be so regulated to prevent one half becoming discharged, but only at the expense of a waste of current in the other half of the battery.

This would probably be serious only in exceptional cases.

I have had running under my charge a balancing machine, similar to that at Burnley, for some months, without, however, any battery being used.

In case of any further adjustment of potential than that given by the machine being required, the following arrangement, which enables the batteries to be either charged or discharged, would probably meet the case.



D, Dynamo; B, Balancer.

No difficulty, however, has been experienced in so arranging the two halves of the system, that the balancing current is almost a negligible quantity.

These machines are very efficient and require practically no attention.

A. G. Seaman.

Lightning Express.

I have read with surprise the article on "Lightning Express" in your issue of the 16th instant. I am unable to understand what has occurred since you wrote on this subject on October 13th to completely alter your views.

Allow me also to say that there is no word in the article of the *Pall Mall Gazette* about any interview with myself, but only about an interview with the chairman of the Thames Iron Works.

You know also that I wrote the article on November 3rd last in your paper at your express request. I am in no way responsible for the article in the *Pall Mall*. No doubt there is a certain amount of confusion in that article between the lightning express and the ordinary Lartigue railways. It is evident that the line in France and that proposed between Charing Cross and Cannon Street, have no bearing on the trials and experiments now in progress relating to the lightning express, and are not meant as an experiment or demonstration of that proposal. What we are doing in that matter is quite distinct from the above projects, and con-

sists in preparing for the construction of a full-sized lightning express trial line, on which the necessary experiments will be carried out to test every part of the proposed system.

I only want to add one word with regard to the centre of gravity. Without wishing to say that this most important subject has been clearly and correctly stated in the *Pall Mall*, I would ask you to refer to fig. 3 on plate 5 of my pamphlet, from which you will clearly see that it is possible to place the centre of gravity on the level of the rail, or above it, or below it, and have in all three cases the centre of gravity above the load.

Now in your article of October 13th, 1893, on my pamphlet you say: "The centre rail, arranged so that the centre of gravity is above the load, must be safer than any of our present two-rail systems."

F. B. Behr.

March 20th, 1894.

A New Key for Lamp-post Switches.

In those districts where arc lamps are employed for lighting thoroughfares or buildings, it is an established rule to cut both leads from any lamp requiring attention, in order that life may be protected.

A key is usually employed for turning off the lamp switch, and although it is quite evident that the removal of this key from the switch is of great importance to the trimmer, it is strange that this act is so often omitted.

In the City of London, it is a matter of constant occurrence to see the trimmer leave his key in the lamp-post.

One of the best methods for ensuring the removal of the key would be to have it attached by a cord round the man's waist, but even then, the chances are, that he would take it off.

A short time ago, I obtained a patent for keeping dust out of pipe-keys. The arrangement consists of a small piston inside the pipe which is pushed to the end by means of a spring, so that practically there is no pipe, excepting at the time the key is placed in the lock, when the pin in the lock pushes the piston back into the pipe, compressing the spring at the same time.

This device I have found useful to avoid the possibility of leaving a key in a safe, because when the key is turned, the action of the spring piston is to push the key out of the lock.

I have suggested that this system should be applied to the keys of the lamp-post switches in the City of London.

My object in asking you to publish this letter is to make the application of this principle, so far as it concerns electric switch keys, public property, and prevent a patent being taken out in this respect.

David Salomons.

Theryc-Oblasser Battery.

"Dr. Fleming was experimenting with new and imperfectly formed plates."

"The accumulators tested by Dr. Fleming had only been sufficiently formed to enable them to stand the transit from Belgium, in order that the Doctor might satisfy himself of the rapidity of the formation."

(See letter from M. Ch. Theryc, p. 306 ELECTRICAL REVIEW.)

"Last year M. Ch. Theryc placed in my hands a small battery of two cells . . . ."

"I gave the battery a fair and impartial trial . . . ."

"With these very cells Dr. Fleming made his experiments."

(See letter from Mr. Fred. E. Everard, p. 338 ELECTRICAL REVIEW.)

How can the two above statements be reconciled?

One who gave it up.

[Probably Dr. Fleming tested both large and small cells, as Mr. Everard is careful to say "I am speaking now of the small cell referred to in Dr. Fleming's report."—EDS. ELEC. REV.]

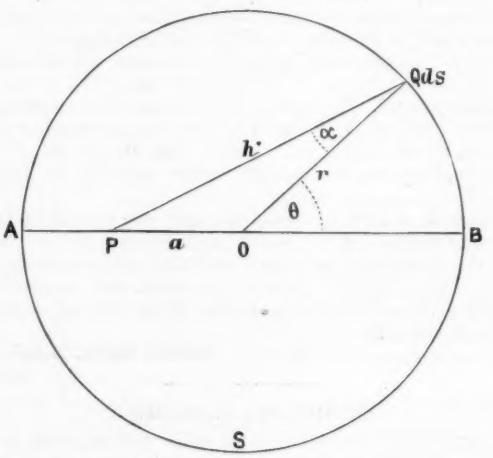
METHOD OF APPROXIMATELY DETERMINING THE MAGNETIC FIELD AT ANY POINT INSIDE A CIRCLE CARRYING A CURRENT.

BY E. C. RIMINGTON.

THE following is a method of obtaining the magnetic field anywhere within a circular coil carrying a current in its plane, on the supposition that the width and depth of the coil are negligible; it involves the use only of comparatively simple mathematics, and can be applied to any point not too near the edges.

Let A Q B be a circular coil carrying a current C, O being its centre. Let O P $= a$ and O Q, the radius, $= r$.

It is required to find the magnetic field at P, any point in the plane of the coil and inside it. Take any point, Q, in the coil and consider the element of length $d s = r\, d\theta$.



Then the strength of field at P due to this element or

$$d\,\mathrm{F} = \frac{\mathrm{C}\, d\, s \cos \alpha}{h^2}.$$

Where $h =$ P Q and α the angle, O Q P.

Its direction is evidently normal to the plane of the coil, so that if we add the fields due to each element, we shall obtain the field at P due to the whole coil, and its direction will be normal to the coil plane.

Now, $h^2 = r^2 + a^2 + 2\, a\, r \cos\theta$, and $\cos\alpha = \dfrac{h^2 + r^2 - a^2}{2\, r\, h}$

$$= \frac{r + a\cos\theta}{\sqrt{r^2 + a^2 + 2\, a\, r \cos\theta}}$$

Therefore, $d\,\mathrm{F} = \dfrac{\mathrm{C}\, r\, (r + a\cos\theta)\, d\,\theta}{(r^2 + a^2 + 2\, a\, r\cos\theta)^{\frac{3}{2}}}$

We may either integrate this expression between the limits $2\,\pi$ and O, or between the limits π and O, which latter will give the field due to the top half of the coil, A Q B, and, since the bottom half, A S B, is perfectly symmetrical with the top half as regards P, it will only be necessary to double our result.

Doing the latter

$$\mathrm{F} = 2\,\mathrm{C}\, r \int_0^{\pi} \frac{(r + a\cos\theta)\, d\,\theta}{(r^2 + a^2 + 2\, a\, r\cos\theta)^{\frac{3}{2}}}$$

$$= 2\,\mathrm{C}\, r^2 \int_0^{\pi} (r^2 + a^2 + 2\, a\, r\cos\theta)^{-\frac{3}{2}}\, d\,\theta + 2\,\mathrm{C}\, r\, a \int_0^{\pi} \cos\theta\, (r^2 + a^2 + 2\, a\, r\cos\theta)^{-\frac{3}{2}}\, d\,\theta.$$

These two expressions cannot be directly integrated. To obtain them we may expand the quantity within the bracket, in the form of an infinite series, by the Binomial theorem. For shortness write $r^2 + a^2 = p^2$,

and $2\, a\, r = q^2$,

then $(r^2 + a^2 + 2\, a\, r\cos\theta)^{-\frac{3}{2}} = (p^2 + q^2\cos\theta)^{-\frac{3}{2}}$

$$= \frac{1}{p^3}\left(1 + \frac{q^2}{p^2}\cos\theta\right)^{-\frac{3}{2}}.$$

Also write $$\frac{q^2}{v^2} = \frac{2\,a\,r}{a^2 + r^2} = \beta.$$

β is always less than unity since a is less than r, unless infinitely near the current, when this method fails. This can be seen from geometrical considerations, or thus

$$\beta = \frac{2\,a\,r}{a^2 + r^2} = \frac{2}{\frac{r}{a} + \frac{a}{r}} = \frac{2}{x + \frac{1}{x}}; \quad \text{where } \frac{r}{a} = x.$$

Hence for β to be greater than unity

$$x + \frac{1}{x} \text{ must} < 2$$
$$x^2 + 1 < 2\,x$$
$$x^2 - 2\,x + 1 < 0$$
$$(x - 1)^2 < 0$$

and since $(x - 1)^2$ cannot be negative, being a square, it cannot be less than zero, or β is never greater than unity.

F may then be written

$$F = \frac{2\,C\,r^2}{p^3}\int_0^\pi (1 + \beta\cos\theta)^{-\frac{3}{2}}\,d\theta + \frac{2\,C\,r\,a}{p^3}\int_0^\pi \cos\theta\,(1 + \beta\cos\theta)^{-\frac{3}{2}}\,d\theta.$$

Now

$$(1 + \beta\cos\theta)^{-\frac{3}{2}} = 1 - \frac{3}{2}\beta\cos\theta + \frac{3\,.\,5}{2^3}\beta^2\cos^2\theta - \frac{3\,.\,5\,.\,7}{2^4\,.\,3}\beta^3\cos^3\theta + \frac{3\,.\,5\,.\,7\,.\,9}{2^5\,.\,3\,.\,4}\beta^4\cos^4\theta - \frac{3\,.\,5\,.\,7\,.\,9\,.\,11}{2^6\,.\,3\,.\,4\,.\,5}\beta^5\cos^5\theta + \frac{3\,.\,5\,.\,7\,.\,9\,.\,11\,.\,13}{2^7\,.\,3\,.\,4\,.\,5\,.\,6}\beta^6\cos^6\theta - \text{\&c.} \quad (A)$$

Multiply by $d\,\theta$ and integrate each term between the limits, π and 0; remembering that

$$\int\cos^n\theta\,d\,\theta = \frac{\sin\theta\cos^{n-1}\theta}{n} + \frac{n-1}{n}\int\cos^{n-2}\theta\,.\,d\,\theta$$
$$= \frac{\sin\theta}{n}\left\{\cos^{n-1}\theta + \frac{n-1}{n-2}\cos^{n-3}\theta + \frac{(n-1)\,(n-3)}{(n-2)\,(n-4)}\cos^{n-5}\theta + \text{\&c.}\right\} + \frac{(n-1)\,(n-3)\,(n-5)\,\ldots\,3\,.\,1}{n\,(n-2)\,(n-4)\,\ldots\,4\,.\,2}\,\theta$$

when n is even;

and $$= \frac{\sin\theta}{n}\left\{\cos^{n-1}\theta + \frac{n-1}{n-2}\cos^{n-3}\theta + \frac{(n-1)\,(n-3)}{(n-2)\,(n-4)}\cos^{n-5}\theta + \ldots + \frac{(n-1)\,(n-3)\ldots 4\,.\,2}{(n-2)\,(n-4)\ldots 3\,.\,1}\right)$$

when n is odd.

Evidently then in integrating between the limits, π and 0, all the odd powers of $\cos\theta$ will vanish, since their integrals contain $\sin\theta$ as a factor, and $\sin\pi = 0$ and $\sin 0 = 0$. In the case of the even powers of $\cos\theta$, the integral

$$\int_0^\pi \cos^n\theta\,d\,\theta = \frac{(n-1)\,(n-3)\,(n-5)\ldots 3\,.\,1}{n\,(n-2)\,(n-4)\ldots 4\,.\,2}\,\pi.$$

Here we may note that just the same result would have been obtained by leaving out the 2, and integrating between limits 2π and 0.

Hence

$$\int_0^\pi (1 + \beta\cos\theta)^{-\frac{3}{2}}\,d\theta = \pi\left\{1 + \frac{15}{8}\beta^2\cdot\frac{1}{2} + \frac{315}{128}\beta^4\cdot\frac{3}{4\,.\,2} + \frac{3\,.\,5\,.\,7\,.\,9\,.\,11\,.\,13}{2^7\,.\,3\,.\,4\,.\,5\,.\,6}\beta^6\cdot\frac{5\,.\,3}{6\,.\,4\,.\,2} + \text{\&c.}\right\}$$
$$= \pi\left\{1 + \frac{15}{16}\beta^2 + \frac{945}{1{,}024}\beta^4 + \frac{45{,}045}{49{,}152}\beta^6 + \text{\&c.}\right\}$$

Similarly $$\int_0^\pi \cos\theta\,(1 + \beta\cos\theta)^{-\frac{3}{2}}\,d\,\theta$$
$$= -\pi\left\{\frac{3}{2}\beta\cdot\frac{1}{2} + \frac{3\,.\,5\,.\,7}{2^4\,.\,3}\beta^3\cdot\frac{3}{4\,.\,2} + \frac{3\,.\,5\,.\,7\,.\,9\,.\,11}{2^6\,.\,3\,.\,4\,.\,5}\beta^5\cdot\frac{5\,.\,3}{6\,.\,4\,.\,2} + \text{\&c.}\right\}$$
$$= -\pi\left\{\frac{3}{4}\beta + \frac{105}{128}\beta^3 + \frac{3{,}465}{4{,}096}\beta^5 + \text{\&c.}\right\}$$

Hence

$$F = \frac{2\,\pi\,r^2\,C}{(a^2 + r^2)^{\frac{3}{2}}}\left\{\left(1 + \frac{15}{16}\beta^2 + \frac{945}{1{,}024}\beta^4 + \ldots\right) - \frac{a}{r}\left(\frac{3}{4}\beta + \frac{105}{128}\beta^3 + \frac{3{,}465}{4{,}096}\beta^5 + \ldots\right)\right\} \quad (B)$$

We must now examine the two series in expression B, to ascertain whether they are convergent.

An infinite series is convergent if from and after any fixed term the ratio of each term to the preceding term is numerically less than unity. Suppose c_1 and c_2 to be the numerical coefficients of two successive terms, then the ratio will be $\frac{c_2}{c_1}\beta^2$ if c_2 be less than c_1, this will obviously be less than unity, and hence the series will be convergent.

Let us first examine the first series in (B). It was derived from (A) by integration. Consider the $(n+1)^{th}$ term of series (A) (n being even) it will be

$$\frac{\frac{3}{2}\left(\frac{3}{2}+1\right)\left(\frac{3}{2}+2\right)\ldots\left\{\frac{3}{2}+(n-1)\right\}}{\lfloor n}\beta^n\cos^n\theta$$

when multiplied by $d\,\theta$, and integrated between limits π and 0, it equals

$$\frac{\frac{3}{2}\cdot\frac{5}{2}\cdot\frac{7}{2}\cdot\ldots\left(n-\frac{1}{2}\right)\left(n+\frac{1}{2}\right)}{\lfloor n}\beta^n\frac{(n-1)\,(n-3)\ldots 3\,.\,1}{n\;(n-2)\ldots 4\,.\,2}$$

or, $$c_1 = \frac{\left(n+\frac{1}{2}\right)\left(n-\frac{1}{2}\right)\left(n-\frac{3}{2}\right)\ldots\frac{5}{2}\cdot\frac{3}{2}}{\{n\,(n-2)\,(n-4)\ldots 4\,.\,2\}^2}$$

Take now the next term in series (B), it will be the next odd term of (A) or the $(n+3)^{rd}$, and will give, when multiplied by $d\,\theta$ and integrated, the value for c_2.

$$c_2 = \frac{\left(n+2+\frac{1}{2}\right)\left(n+2-\frac{1}{2}\right)\left(n+2-\frac{3}{2}\right)\ldots\frac{5}{2}\cdot\frac{3}{2}}{\{(n+2)\,n\,(n-2)\ldots 4\,.\,2\}^2}$$

Hence,

$$\frac{c_2}{c_1} = \frac{\left(n+\frac{5}{2}\right)\left(n+\frac{3}{2}\right)\left(n+\frac{1}{2}\right)\ldots\frac{3}{2}}{\left(n+\frac{1}{2}\right)\left(n-\frac{1}{2}\right)\ldots\frac{3}{2}}\cdot\left\{\frac{n\,(n-2)\ldots 4\,.\,2}{(n+2)\,n\,(n-2)\ldots 4\,.\,2}\right\}^2$$
$$= \frac{\left(n+\frac{5}{2}\right)\left(n+\frac{3}{2}\right)}{(n+2)^2}$$
$$= \frac{\left\{(n+2)+\frac{1}{2}\right\}\left\{(n+2)-\frac{1}{2}\right\}}{(n+2)^2}$$
$$= \frac{(n+2)^2 - \frac{1}{4}}{(n+2)^2}$$

Therefore $\frac{c_2}{c_1}$ is less than unity whatever n, or the first series of (B) is convergent.

As regards the second series in (B).

Take the n^{th} term of series (A), multiply by $\cos\theta\,.\,d\,\theta$, and integrate, we obtain for c_1,

$$c_1 = \frac{n\left(n-\frac{1}{2}\right)\left(n-\frac{3}{2}\right)\ldots\frac{5}{2}\cdot\frac{3}{2}}{\{n\,(n-2)\,(n-4)\ldots 4\,.\,2\}^2}$$

The next coefficient will be obtained from the $(n+2)^{nd}$ term of series A, and will be

$$c_2 = \frac{(n+2)\left(n+2-\frac{1}{2}\right)\left(n+2-\frac{3}{2}\right)\ldots\frac{3}{2}}{\{(n+2)\,n\,(n-2)\ldots 4\,.\,2\}^2}$$

$$\therefore \frac{c_2}{c_1} = \frac{(n+2)\left(n+2-\frac{1}{2}\right)\left(n+2-\frac{3}{2}\right)\ldots\frac{3}{2}}{n\left(n-\frac{1}{2}\right)\left(n-\frac{3}{2}\right)\ldots\frac{3}{2}}$$

$$\left\{\frac{n(n-2)\ldots 4\,.\,2}{(n+2)\,n\ldots 4\,.\,2}\right\}^2 = \frac{\left(n+\frac{3}{2}\right)\left(n+\frac{1}{2}\right)}{n\,(n+2)}$$

$$= \frac{n^2 + 2n + \frac{3}{4}}{n^2 + 2n}.$$

This is greater than unity, but approaches unity as n is increased, so that, since β^2 is a fraction, this series is also convergent.

It can also be shown that none of the coefficients of the powers of β in expression (B) are ever greater than unity. Hence if β be a fairly small fraction the two series will converge fairly rapidly.

Suppose $\beta = \frac{1}{4}\left(i.e., a = \cdot 12\, r, \text{ since } a = \frac{r}{\beta}(1 - \sqrt{1-\beta^2})\right)$

Then the *third* term of the first series will be less than $\frac{1}{256}$, and the *second* term of the second series less than $\frac{1}{533}$ (since the second series is multiplied by $\frac{a}{r}$, in this case ·12).

If $\beta = \frac{1}{2}$ (*i.e.*, $a = \cdot 27\ r$), the fifth term of the first series will be less than $\frac{1}{256}$, and the fourth term of the second series less than $\frac{1}{500}$. Of course for larger values of β more terms would have to be taken.

If β equals unity, the first series in expression (B) will still be convergent, but the second series will be divergent; if, however, β be less than unity the second series must be convergent, as if n be taken sufficiently large $\frac{n^2 + 2n + \frac{3}{4}}{n^2 + 2n}\beta^2$ will be less than unity.

Practically, however, if β is too near unity in value the series will not, either of them, converge rapidly enough to make the expression for F of any practical value.

Suppose a to be much smaller than r, then

$$\beta = \frac{2ar}{a^2 + r^2} = \frac{2a}{r} \text{ approximately,}$$

and

$$(a^2 + r^2)^{\frac{1}{2}} = r^3\left(1 + \frac{\beta^2}{4}\right)^{\frac{1}{2}}$$

Hence

$$F = \frac{2\pi C}{r\left(1 + \frac{\beta^2}{4}\right)^{\frac{1}{2}}}\left\{1 + \left(\frac{15}{16} - \frac{3}{8}\right)\beta^2 + \left(\frac{945}{1{,}024} - \frac{105}{256}\right)\beta^4 + \&c.\right\}$$

$$= \frac{2\pi c}{r}\left(1 + \frac{\beta^2}{4}\right)^{-\frac{1}{2}}\left\{1 + \frac{9}{16}\beta^2 + \frac{525}{1{,}024}\beta^4 + \&c.\right\}$$

and, since β is very small,

$$F = \frac{2\pi c}{r}\left(1 - \frac{3}{8}\beta^2\right)\left(1 + \frac{9}{16}\beta^2\right) \text{ approximately}$$

$$= \frac{2\pi c}{r}\left\{1 + \frac{3}{4}\left(\frac{a}{r}\right)^2\right\} \text{ approximately.}$$

This gives the correction that has to be applied in the case of a tangent galvanometer for very small deflections, and a is, of course, half the length of the needle.

In all the above cases if there be n turns of wire in the coil, the value of F has to be multiplied by n.

A QUACK SENTENCED TO FIVE YEARS' IMPRISONMENT.

Before the Liverpool Assizes last week, Francis M'Conville, thirty-four, patent medicine vendor, was charged with having on September 4th, 1890, and on other dates at Liverpool unlawfully and by means of false pretences obtained from John Gardner several sums of money, amounting to £52 12s., with intent to defraud. Mr. Swift prosecuted, and the prisoner was defended by Mr. Shee, Q.C., and Dr. Commins, M.P.

The case for the Crown was that the prisoner, who styled himself "Professor Hamilton," had obtained the above-named sum of money from John Gardner, a working man who lived in the North of Ireland, by the false pretence that he (prisoner) was a duly qualified man. It seemed that the prisoner had a shop, 14, Brunswick Road, which was called "The Medical Institute," and from that place there were issued leaflets setting forth that certain diseases could be cured One of these fell into the hands of Gardner, who wrote to "The Medical Institute." From that time until February, 1893, letters passed between "Professor Hamilton" and Gardner, in which the former gave advice, and the latter forwarded from time to time fees including one, five, ten, and even fourteen guineas. Twice Gardner was induced to come to Liverpool, and on going to "The Medical Institute" he saw the prisoner, who was "the professor." In 1891 Gardner received another letter, in which "the professor" recommended the use of an electric appliance or belt, which had to be worn round the body, to which it would give tone and health, and would also invigorate the system. To procure that belt Gardner had to send to the prisoner another twelve guineas. (Laughter.) That belt was sent to Gardner, who had worn it, but had received no good from it, and the prosecution would prove by experts that there was no electricity about it, and that it was utterly useless. This sort of thing went on for some time, until, in fact, Gardner had sent to the prisoner £52 for remedies, advice, &c. Nearly all the letters were signed "A Hamilton," and only one was signed "Resident Surgeon, A. Hamilton, Secretary." Gardner would state that he would never have sent the money had he not believed that he was dealing with a fully qualified professional man.

A number of witnesses were called to show that prisoner was known as "Professor Hamilton," and that in his establishment there was at that time a Dr. D. Collins.

A. P. George, a surgical attendant at that place, stated that prisoner had not the slightest knowledge of medicine or surgery. There was a Dr. Collins in the establishment, but his chief duties were opening the door and lighting and putting out the gases. (Laughter.)

His Lordship: That's the fully qualified medical man? (Renewed Laughter.)

Mr. Swift: Yes, my lord, the eminent surgeon who is referred to in the leaflet. (Laughter.)

Benjamin Davies, private secretary to Prof. Lodge, of the University College, stated that he had examined the belt which was sent to the prisoner, and was of opinion that it was incapable of conveying through the body a current of electricity.

Evidence of a similar nature was given by Dr. Paull.

Mr. Shee, for the defence, reminded the jury that to find a verdict of guilty they would have to say that the prisoner intentionally obtained the money by false pretences, and that the man Gardner was deceived. He submitted that the prisoner had not represented himself as a qualified man, but had simply done what any other person might do without infringing the law, namely, started a business in which he could use his special knowledge, and kept duly qualified medical men on the premises. Why, if the prisoner had been pretending to be a doctor he could have been proceeded against long ago by the police, who had known him for over six years. Nor had the prisoner attempted to deceive anyone with respect to the belts, for they were made on a principle which prisoner honestly believed would create a current of electricity, and, what was more, would be spoken of by witnesses as most valuable. Finally, there were not the slightest grounds for believing that Gardner had been taken in at all by the prisoner.

Dr. D. Collins was called, and stated that it was his duty, whilst in the employ of the prisoner, to attend to the patients.

Arthur H. Maddocks, undergraduate, Queen's University, and Thomas Brownrig, deposed that they were engaged by prisoner as assistants to Dr. Collins.

Robert Watson, of Birkenhead, William Moore, Arthur Moseley, of Liverpool, and other witnesses from the district, gave evidence of having had advice at the institute, and worn the belts supplied by prisoner, which did them great good.

The jury found the prisoner guilty.

Detective Fisher informed the Court that the prisoner some years ago was a billposter for a person who carried on a "quack" business. After leaving that man the prisoner set up for himself, and at the present time his books showed that he was making between £3,000 and £4,000 a year. His advertising bill was at times over £400 for a few months. He had been several times fined for causing to be circulated, and for himself distributing, obnoxious literature.

His Lordship said that it was time the prisoner's career was cut short. He had been found guilty of most cruel frauds on persons who, though not ashamed of their vices, were ashamed of the consequences. The police had been fortunate in unearthing the prisoner, and he (the Judge) would sentence him to five years' penal servitude, which was the maximum penalty for such an offence.

BOOKS RECEIVED.

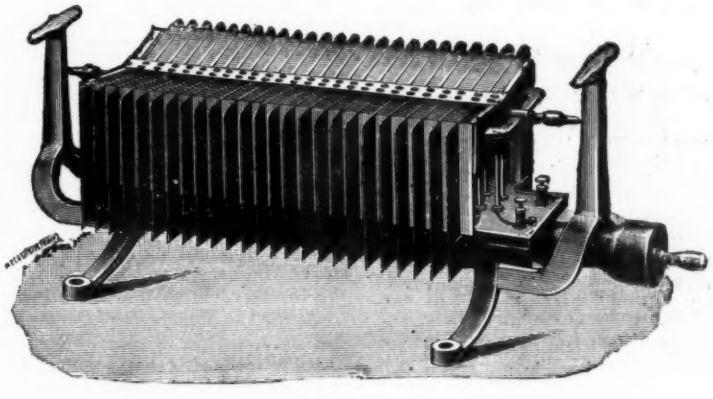
Electro-plating. By John W. Urquhart. Published by Crosby Lockwood & Son, 7, Stationers' Hall Court, E.C.

Willing's British and Irish Press Guide for 1894. 21st annual issue. Published at 125, Strand, W.C. Price 1s.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's) for 1894.—Published by H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London, E.C. This directory comprises the names of 18,414 different individuals and firms, is divided into four sections, namely, British, Continental, American and Colonial, each of these being sub-divided into alphabetical and classified sections. There are about 800 pages consisting entirely of directory matter, making the book the fullest, as it is the oldest, electrical directory in the world. The price of the work is 4s., post free.

Gülcher Thermopiles.—It is only recently that the Gülcher Patent Thermopiles have been introduced into this country, although we have already referred to them in these columns as being on the Continental market. Messrs. O. Berend & Co. are the agents for the apparatus in this country. This thermopile is suitable for a variety of purposes; it can be used in chemical and physical laboratories, for electro-medical, dental, and telegraphic purposes, electro-plating and electrotyper's work, for school and demonstration purposes, and for temporary lighting. We give an illustration of the apparatus, for which the following advantages are claimed:—highly constant electromotive force, small consumption of gas, high efficiency, no vapours, no smell, no polarisation, therefore no exhaustion, great durability. The following are the instructions for use:—First place the tubular porcelain chimneys in their places, on top of the elements, by inserting the projecting mica tube in the holes until the porcelain rests on the metal; in this position they must remain. Thereupon connect the thermopile by a rubber tube to the gas supply, open the tap, and after a lapse of about half a minute—the time it will take for the air to escape from the tubes—set light to the gas escaping from the tubular elements at the mouth of the porcelain chimneys. When the burners are lighted the thermopile is ready for use, and requires no further attention. In 8 to 10 minutes after lighting up, the pile is sufficiently heated to give off a *perfectly constant E.M.F.* Before packing, each thermo-pile is carefully tested, and adjusted to the highest admissible gas pressure, viz.: 50 mm. = 1·96 inch water column. As the gas pressure varies considerably, it is advisable to always insert a gas pressure regulator, but in most instances the gas companies will be able to inform users of their normal pressure, and when such normal pressure does not surpass the maximum, it is not necessary to use a regulator.



Belfast Exhibition Lighting.—At the Belfast Arts and Industrial Exhibition, which was opened last week, the Edison and Swan United Electric Light Company have a stand upon which they exhibit a host of incandescent lamps, from ¼ to 2,000 C.P., and various electric light fittings. The exhibition buildings are lighted throughout by electricity, the contractor being Mr. C. C. MacCarthy, of Belfast. The plant comprises two 500-light dynamos, manufactured by the Taunton Electrical Engineering Company, and driven by a gas engine. In the Ulster Hall there are several large 200 candle-power lamps; rows of 16 candle-power lamps are arranged under the balconies between each stall, and above the platform is a 450 candle-power light, at each side of which are two rows of 100 candle-power lamps, three in each row, in addition to which Messrs. Gibson & Co. have six 16-candle-power lamps at their stand. In the Minor Hall there are three lamps of 200 candle-power, five of 25 candle-power, and at Messrs. Arnott and Co.'s stand eight of 16 candle-power. In the annexe there are 15 lamps of 200 candle-power and two arc lamps, and in each of the corridors there are 10 16-candle-power lights.

Guildford Electric Lighting.—The committee which has had under consideration the electric lighting question is still of opinion that the powers should be in the hands of the council. The latter authority has accordingly decided to oppose the application of a private body for a provisional order, unless a special clause regarding the council's right to acquire the undertaking be inserted in such order.

Kingston Electric Lighting.—The Local Board have resolved to obtain an additional dynamo and connections, at an estimated cost of about £240, for work during the daytime, and Mr. Preece has been requested to report upon the kind of engine to use with it. Letters were received from Messrs. Willans & Robinson, alleging infringement of their patent in regard to the bed-plate and crank chamber of the engines in use at the works. The Town Clerk replied that the Corporation were no parties of any infringement, and that the whole responsibility to any infringement was with the contractors. Messrs. Siemens wrote admitting their liability to guarantee the Corporation against any claims in respect of patent rights and royalties on the plant. The two arc lamps at the works, and a bracket, were ordered to be purchased from Messrs. Siemens at a price not exceeding £44.

Electric Lighting in Dundee.—It has been reported that for the year ending March 15th the revenue from the electric light had amounted to £2,644 5s. 3d., including £92 6s. 8d. for meter rents and £2,551 18s. 7d. for energy supplied. Of the latter sum, £2,384 8s. 7d. was realised from the meters, and £167 10s. from the public lamps. When the installation was gone into the revenue had been estimated at £2,000, and the meter rents at £35, but, as the figures submitted showed, there had been a considerable increase. The probability, however, was that there would be a corresponding increase in the expenditure. As the financial year did not close until April 30th, it would be impossible to give any indication as to the result of the year's working, or to state whether the cost per unit will be increased or reduced.

Hotel Electric Lighting.—Messrs. Maunsell Mercier and Co. of Deansgate, have secured the contract for wiring, fittings, and complete plant for about 600 16-candle-power lamps in the Deansgate Hotel, Manchester. The generating plant will consist of 2 30-B.H.P. "Premier" gas engines and 2 dynamos driven from countershafts. To minimise the risk of failure (no gas being put in), 2 circuits will be run all over the building, and the lamps will be alternately on each circuit. The main switchboard will have 2 voltmeters, 2 ammeters, 2 double-pole main switches, and 18 two-way branch switches, so that any circuit may be switched on to either machine. Provision will be made in engine house for a spare engine and dynamo. The architects are Messrs. Moffat & Bentley of Whitehaven.

Private Installations.—Messrs. Baxendale & Co., of Manchester, have just secured the contracts for a complete lighting plant for the Bromley Mills, Manchester; complete wiring of Wesleyan Chapel, Nelson, for Corporation supply; complete wiring of both establishments of Messrs. W. Thompson & Co., Spring Gardens, Manchester, for Corporation supply; and Messrs. Smallman's new restaurant, Manchester. We have received a circular setting forth a number of installations that have been carried out by Messrs. Baxendale.

Ship Lighting.—From the yard of Messrs. Ramage and Ferguson, Limited, at Leith, last week, was launched a large steam yacht which is fitted with a complete installation of electric light.

Messrs. W. B. Thompson & Co., Limited, launched from their yard at Dundee on 22nd inst., a screw steamer which was fitted throughout with electric lighting by Messrs. W. C. Martin & Co., of Glasgow. The installation includes two sets of direct-acting engines and dynamos.

Electric Lighting of City Churches.—From Messrs. H. F. Joel we have received a circular illustrative of the ancient church of St. Nicholas Cole Abbey, and of the electric lighting work that was in 1892 carried out there by them. The main body of the church is lighted with 11 200-C.P. incandescent lamps, and a number of smaller lamps are distributed throughout the various vestries, &c.

National Building Exhibition.—Mr. Harry South is making a good show of fittings at the above exhibition, now being held at the Agricultural Hall. A joint stand, occupied by Mr. South and the Coalbrookdale Iron Company, is rendered most attractive by the use of the electric light, the electroliers in use being of elegant design.

Willing's Press Guide.—The twenty-first annual issue of this valuable press directory has just been published. It contains information regarding all the British and Irish newspapers and journals published in the chief centres of the world. Messrs. Willing are to be congratulated upon the handy way in which they have set out the particulars for easy reference. The book is divided into a number of sections, the alphabetical being the most useful; the other sections set forth the class of paper, and separate the Metropolitan, English, Scottish, Irish and foreign publications.

Taunton Electric Lighting.—The extensions are said to be progressing satisfactorily. Mr. J. A. Robinson, of the Great Western Railway, is leaving Taunton, and the Town Council have voted £5 5s. for the purchase of a present in recognition of his advice and assistance in connection with the carrying out of the electric lighting works during a period of great difficulty and anxiety.

Personal.—Mr. Arthur W. Hine, of Parkstone, Dorset, who is the late managing director of Roper's Electrical Engineering Company, Limited, asks us to state that he sails on April 7th for Mashonaland (Fort Salisbury), where he intends starting business as an electrical and mechanical engineer. We hope Mr. Hine's career in Africa will be successful.

Stirling Electric Lighting.—The Caledonian Electric Supply Company's application for a Provisional Order has now been granted. The Town Council have since appointed an electric lighting committee to watch over the interests of the ratepayers, and accelerate the introduction of the electric light into the borough as much as possible.

A Novelty at Blackpool.—At the Blackpool Winter Gardens Prof. Leamy exhibits an aerial cycle trapeze, which is illuminated by a number of incandescent lamps shaded in various colours. There are 32 lamps on the cycle, and the work was executed by Mr. Alec Fairley, the Garden's electrician.

Price List.—From Mr. K. Schall, of Wigmore Street, W., we have received an additional price list, No. 1, which is intended as a supplement to his general catalogue. The list deals with electro-medical instruments, and also includes particulars of second-hand batteries and instruments for sale.

Electric Light at York.—The York branch of the National and Provincial Bank of England, last week, entered into their newly erected premises, at the corner of Market Street and Spurrier Gate, where provision is made for both gas and electric lighting.

Country House Lighting.—The electric lighting of "Merrow Grange," for Mr. F. Baring Gould has been placed in the hands of Messrs. Allpress & Co., of Westminster. The dynamo will be run by an oil engine, and accumulators will be used. The engine house will be built some distance from the mansion.

International Cable Company.—The Official Liquidator of this company, Mr. F. S. Lucey, announces that, by an order dated February 15th, 1894, the chief clerk directed a dividend of 20s. in the £ to be paid to the creditors of the company.

Chiswick Electric Lighting.—The Clerk has been instructed to write to Messrs. Bourne & Grant to proceed with the electric lighting of Chiswick, otherwise the Local Board would communicate with the Board of Trade.

Electric Light for Tramcars.—For nearly a fortnight the London Tramways Company have been experimenting with the electric light upon their cars running between Westminster and Streatham.

Infirmary Lighting.—Southport New Infirmary is to be lighted by gas, although a number of members of the committee voted in favour of electric lighting.

New Swindon and Electric Lighting.—The question of applying for a Provisional Order is under consideration. Mr. J. G. M. Aldridge is to be paid 25 guineas for his report.

Workhouse Lighting.—The question of lighting the workhouse at Crumpsall with the electric light has been referred to a committee.

Montrose and Electric Lighting.—The Burgh Commissioners are considering the electric lighting question, and hope to report on the matter at the next meeting.

Dartford and Electric Lighting.—A member of the Local Board is preparing a scheme for the adoption of the electric light, and the Gas Company's contract has only been renewed for one year.

Oswestry and Electric Lighting.—The seal of the Town Council has been affixed to the agreement with the Oswestry Electric Lighting Company.

St. Austell Electric Lighting.—There was a slight failure of the electric light on the 18th inst.

Club Lighting.—The Leeds and County Unionist Club have decided to instal the electric light in their new premises.

Liverpool Electric Lighting.—Last week two electric lamps were placed at the bottom of London Road as an experiment.

NOTES.

Royal Institution.—In our note last week we were unable to give the dates for the delivery of the various lectures mentioned. The following are fuller details:—Friday, April 6th, Prof. Victor Horsley on "Destructive Effects of Projectiles;" April 13th, Prof. J. J. Thomson on "Some Properties of the Electric Discharge through Gases;" June 1st, Prof. Oliver Lodge on "The Work of Hertz;" four Tuesday lectures by Prof. J. A. Fleming on "Electric Illumination," on April 3rd, 10th, 17th, and 24th; three Thursday lectures by Prof. Dewar on "The Solid and Liquid States of Matter," May 3rd, 10th, and 17th. The annual meeting of the Institution will be held on Tuesday, May 1st, at 5 o'clock.

Effects of Heat on Lead Pipes.—In the case of a recent electric lighting installation, exhaust steam by some means found its way into the ventilating and soil pipes leading to the drains. One of the first evidences of this was found in the warping of all lead pipes so used. It appears, says the *Practical Engineer*, that the heat of the exhaust steam caused the lead pipes to expand and warp, but when the steam was entirely prevented from entering the drains the lead would not contract, and all such pipes had to be straightened by hand. This is a point which embryonic engineers would do well to keep in mind, as each time the pipes were heated they expanded, but in no case did they show any signs of coming back to their normal condition.

Lectures.—The ninth ordinary meeting for the current session of the Philosophical Society of Glasgow was held last week, when Mr. W. B. Sayers read a paper on the subject of "Dynamo-Electric Machinery and some of its Applications."

Dr. Waghorn has lately delivered a course of lectures on "Electricity," at the Parochial Institute, Brixton.

Before the Manchester Literary and Philosophical Society last week, a paper by Mr. Julius Frith on "An Analysis of the Electromotive Force and Current Curves of a Wilde Alternator under Various Conditions" was read.

Dr. Woods, of the Richmond Hospital, Dublin, has announced a course of post-graduate lectures in "Electricity as applied to Medicine and Surgery," to be given in the hospital on Wednesdays and Saturdays during the summer session.

Another Accident at Bournemouth.—The leakage accident has no sooner been reported upon by Major Cardew than that gentleman is again summoned on behalf of the Board of Trade to make a report upon another mishap connected with the electric light supply. On 21st inst., while some men were working in St. Stephen's Road, they were startled by the sounds of an explosion, accompanied by a vibration of the ground around them. There was an upheaval of a foot or two of the road immediately over an electric main box. On the matter being reported to the Electric Light Company, an examination of the box was made, but there was nothing to account for the explosion. Another box close by was opened, and when the iron lid of this had been removed an electric spark at once made the defect visible. The explosion is attributed to an accumulation of gas in the box, the gas being fired by the electric spark. The leakage was immediately attended to.

Folkestone Electric Lighting.—At the last meeting of the Town Council the report of the Electric Lighting Committee was put in, and after some very heated discussion had been indulged in, it was arranged to call a special meeting to consider this report. In the course of the discussion an alderman, who is a large gas shareholder, attempted to take part. This caused a great uproar among the members, the alderman defying the chairman's ruling, which was to the effect that he would be acting illegally in voting upon the electric lighting question. The alderman, to say the least of it, was unwise in some of his remarks, especially when he said that unless he was restrained by *mandamus* he would vote as he considered it perfectly legal. However, he has something yet to learn, and we hope he will have found out his error by the next meeting of the Town Council, and will hold his peace accordingly.

The Northern Society of Electrical Engineers.—A smoking concert is to be held at the Palatine Hotel, Hunt's Bank, Manchester, on Monday evening, April 2nd.

Personal.—The Corporation of Kingston-upon-Thames have increased the salary of the borough electrical engineer (Mr. J. E. Edgcome) to £250 a year. They have also appointed Mr. Edgcome advising engineer to the Drainage Committee.

School Lighting.—Finchley School Board recently considered whether to light the schools by electricity, and applied for a loan. This the Education Department have refused to sanction, with the result that the matter has been cast aside. It was stated that the electric lighting would annually cost about £120 to £130, while gas was only £45.

A Well Deserved Punishment.—The electric belt business seems to be breaking out in another place, the enormous sums made by the sale of an article worth at the most 5s. for as many guineas, apparently being irresistible to the venturesome. But the punishment meted out to "Prof. Hamilton," details of which may be seen in another column, ought surely to make the gentry who fatten on such ill-gotten gains hesitate before committing themselves, lest they should be committed. But when we read of a man who was bill-poster for a quack, going into the same "profession," and making £3,000 to £4,000 a year, the temptation to those who are free from the pricks of conscience seems enough to decide them to risk even the chances of imprisonment. As the learned judge justly remarked, it was time that the prisoner's career was cut short, and we commend the action of the Liverpool police, in unearthing this fraud, to the notice of the authorities in London, whose dilatoriness and apathy in similar matters here has been nothing short of a disgrace to the great metropolis.

The Electric Lighting of Glasgow.—On the 20th inst., at Glasgow, a paper on "The Corporation Electric Light Supply" was read to the members of the Institution of Engineers and Shipbuilders by Mr. William Arnot, electrical engineer to the Corporation. Mr. Arnot described in detail the machinery and other fittings at the Waterloo Street Station, where, he said, they had made ample provision against any accident that might happen. The total output of the dynamos was 1,189,900 watts, or 1,190 units. Describing the underground work in the streets, Mr. Arnot said that a copper strip was laid on porcelain insulators in iron culverts, which were water-tight. He did not mean that under a pressure they would keep out water, but owing to their construction, the lids overlapping the culverts, the ground in which they lay must be flooded before the water could rise high enough to enter through the seam. He had never known an instance of water in the culverts. Water did collect in the brick junction boxes, especially in Bath Street and districts where there was heavy clay soil. Provision was made in all such for their thorough drainage. Where it was not possible to lay copper strip, India-rubber covered cables had been laid in cast-iron pipes. Faults in the underground mains were easily found by means of a compass needle. The needle was placed on the faulty conductor and brought to be parallel with it by means of a strong directing magnet. The other conductor was flashed to earth, and the direction of the excess current due to the fault was noted. In this way it was easily traced. Nearly all the faults were caused by careless workmen. The last fault was in Renfield Street, and was traced in half an hour. There were now 382 consumers, who had applied for a current of 15,487 ampères, which represented, roughly, 46,460 8-candle-power 33-watt lamps distributed somewhat as follows:—242 shops, 7,776 ampères; 21 warehouses, 2,680 ampères; 91 offices, 3,269 ampères; 3 churches, 229 ampères; 12 private houses, 275 ampères; and 13 clubs, hotels, and theatres, 1,258 ampères. They had not had a year's run at the station yet, and it was therefore impossible to give figures as to cost of production, &c. It was only right that he should say that the successful issue of their winter's labours had been due in a very great measure to the staff that had worked with him, and he wished to express his personal appreciation of their services. The paper was illustrated by diagrams.

Theatre Electric Lighting.—The theatre at Scarborough Spa is to be lighted by electricity.

Club Lighting.—Members of the Liverpool Junior Reform Club are to pay an extra subscription, to provide funds for lighting the premises by electricity.

Sunderland Workhouse Lighting.—A committee of the Board of Guardians has been appointed to consider the advisability of lighting the whole of the workhouse by electricity.

Llandrindod Wells and Electric Lighting.—The chairman of the Local Board recently inspected the electric lighting installations at Morecambe and Blackpool. After making enquiries, he was convinced that an installation worked by gas power was the most suitable for their district.

Gas v. Electricity.—The electric light is said to be proving a costly illuminant in the Western Club, Glasgow. Their largest gas bill for one year is stated to have been about £400, and it is said that, so far, the electric light has cost about £90 per month. During the summer months, of course, this figure will be largely reduced.

Bath Electric Lighting.—The Lighting Sub-Committee have declined to sanction a proposed application of the Bath Electric Light Company for power to extend their mains beyond the present area. It would be interesting to know why consent has not been given.

Society of Arts.—On Monday, April 2nd, at 8 p.m., a Cantor lecture on "Photometry" will be delivered by Captain W. de W. Abney, C.B., F.R.S. Lecture I.:—White Light—Sources of Light—Standard Lights—Quality of Light from different Sources.

The Telephone in Canada.—The Bell Telephone Company, of Canada, has issued its annual report, which shows that 2,639 new subscribers were added during the past year, and that there are now 28,806 sets of instruments under rental. The company owns and operates 275 exchanges and 256 agencies throughout the country. The long distance system has been extended, and covers the territory between the City of Quebec and the City of Windsor, in the province of Ontario. It comprises 12,071 miles of wire, on 5,068 miles of poles, and connects together the exchanges of nearly all the cities and towns in the provinces of Quebec and Ontario. The gross revenue for the year was $961,174; the expenses were $724,791; the net revenue was $236,383; the paid up capital is $2,421,600.

Utilisation of Canadian Falls.—The Montmorency Electric Power Company, of Quebec, Canada, which recently purchased at a cost of $260,000 the entire water privileges of the Montmorency Falls, including the adjoining land, has completed its new power station. The Falls are one of the sights of the City of Quebec, and have an available head of 160 feet at the station. The plant comprises four 620-H.P. water-wheels, and four 310-H.P. wheels, set horizontally, and running at 600 revolutions per minute. The smaller wheels operate the arc plant, which is of the Thomson-Houston type. The larger wheels are for the alternating dynamos, which are now being manufactured by the Royal Electric Company, of Montreal. The dynamos are to be of 210 kw. capacity each, and are to run at 600 revolutions per minute, with a current frequency of 60 periods per second and a pressure of 2,000 volts, compounded to give 2,500 volts at full load. They have stationary armatures and revolving fields, and are the first of the type to be made in Canada. The armatures contain no iron, and the coils are interchangeable, so as to be easily replaced. Two dynamos will be mounted on a single base and connected by a clutch coupling, so that they can be arranged to run in parallel, or to give two-phase currents for power. Each pair will be belted to one of the 620 H.P. wheels. The current will be used for light and power, and will be transmitted to the city, a distance of six miles in a direct line. The new station is to be in operation about May 1st next, and will replace the old station which is now supplying light to the city.

The City Company's Works.—The City of London Union have considered that it is now time that the City of London Electric Lighting Company's works should be valued for the purposes of assessment.

The Electro-Harmonic Society.—The last "Smoker" of the present season takes place this evening, when it is to be hoped that a large muster of members and friends will assemble, for the programme is exceptionally good.

Weston-super-Mare and Electric Lighting.—Some of the tradesmen and ratepayers have petitioned the Town Commissioners to put into operation, as soon as possible, the electric lighting powers recently obtained. An Electric Lighting Committee has been formed to consider the memorial.

Obituary.—We regret to announce that Sir Philip Cunliffe Owen died on Friday, 23rd inst., at the age of 66. He was prominently connected with the Department of Science and Art, South Kensington Museum, &c., and assisted materially in modern developments of science.

Lightning Express.—Mr. Behr has read with surprise the article on "Lightning Express" in our issue of the 16th. We are equally surprised that he should call a letter of his own to our correspondence columns an article; and after looking through what we said in October of last year, we fail to find that our views have changed in the least.

The Eight Hours' Movement.—Messrs. Mather & Platt have reported upon their trial year of the forty-eight hours' week, as against six preceding years of 53 hours per week, and on all points the firm has convinced itself that the eight hours' day is the happy medium, and this it has resolved to adopt. Many interesting and remarkable facts have been noted, and by large employers of labour throughout the United Kingdom this report will be read with the keenest interest, for it seems at the first glance to be most beneficial to employers and workmen alike, and we hope to allude to it very fully in a future issue.

"Science Siftings."—In our "Notes" pages of March 16th we drew attention to the first of a series of papers on Medical Electricity, by "Heretic," M.D. To our strictures *Science Siftings* attempts to reply in much the same terms as does "Heretic" himself in to-day's issue, but both quite ignore the real gist of the thing. "Heretic," M.D., commenced with an exposition of the voltaic cell, and had committed his egregious error of stating that the current from two cells an inch square will give nearly twice the current of one cell of any larger size, without any reference whatever to the external resistance. That came afterwards, and is entirely confined to the paragraph concerning skin resistance. We are sorry, therefore, that we cannot oblige our contemporary by withdrawing anything we have said concerning the early principles involved in Ohm's law, but we might go much further in our criticisms if space permitted. We have conclusively proved over and over again that the current from discs of zinc and copper arranged on a belt have no physiological action on the body, so we fail to see why "Heretic" brings that forward, unless it is to show that he has not read the evidence given in the Harness prosecution, but when he says that polarisation causes the current to cease after a minute or so, he is again utterly wrong; in fact, the further he plunges into the subject, the more does confusion become worse confounded. Indeed, his attempt to enlighten the readers of *Science Siftings* on medical electricity is only equalled by the celebrated dissertation in the *Coatbridge Express* on the electric light, while the letter on that same topic from Dr. Gerard Smith, in our current number, and that preceding it, bear a suspiciously striking resemblance. Still, we have no desire to do aught which may impair the "daring, and, therefore, instructive suggestiveness," as our contemporary has it, of the articles from "Heretic," M.D., which are to follow, for anything to stop the traffic in bogus appliances is to be most heartily commended. But to *Science Siftings*' candid avowal that it expressly relaxed its usual strictness of revision with respect to these articles, we can only say, for the sake of its readers, Don't do it again!

CITY NOTES.

Birmingham Electric Supply Company.

We referred to this company's accounts in our issue of March 16th, and spoke of the fairly successful year that the company had experienced. We are now able to put before our readers an analysis of the costs of generation.

	1891.	1892.	1893.
Total capital expenditure ...	—	—	£72,666
Number of units sold	—	—	352,096
Number of lamps connected ...	—	8,329	10,223
Revenue from sale of current...	—	—	£9,835
Average price obtained per unit	—	—	6·7d.

Cost of Production.	£		Per unit.
Coal	1,294		·88d.
Oil, waste, water, and engine room stores	268		·18d.
Salaries and wages at generating station	854		·58d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	618	(Works cost 2·06)	·42d.
Rates and taxes	505		·34d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance.. ..	1,733		1·18d.
Depreciation of buildings and plant account	1,872		1·27d.
Renewal fund account	nil		—
Total	£7,144		4·85d.

Revenue.			Average price obtained per unit.
By sale of current	9,835	0 0	6·7d.
Meter rents	372	0 0	—
Sale of lamps	—		—
Total	£10,207	0 0	6·7d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·58d.; works cost, 2·06d.

London Refuse Steam Company.

Thanks to our contemporary, the *Pall Mall Gazette*, the Livet prospectus has had more light shed upon it than usually falls to the lot of new companies. In addition to suggesting most pertinent questions, it has encouraged a correspondence which has become almost fierce in its character. The officials of the company have been for over a week busy making singularly lame replies to the attacks of the critics. We do not propose to take our readers through the whole of this correspondence, interesting and instructive as it is; but the secretary of the company, in replying to the remarks of a vestryman, makes some curious statements, almost amounting to contradictions. He says that the public are only asked to subscribe £200,000; however, a perusal of the prospectus would not lead us to this view, but that the public were, in the first instance, asked to subscribe £400,000, though doubtless the company would feel satisfied if they obtained a good deal less. Further inaccuracies are perpetuated as to what per cent. of rubbish the Livet boiler will consume, but they are so admirably dealt with by a correspondent signing himself "Specialist," that we need not attempt to show the fallacy of the statement. The main impertinence, however, of the company's letter, is that it accuses the "vestryman" of a careless study of the company's prospectus. Now it has been admitted in the course of this correspondence by the engineer of the company that errors have crept into the prospectus. Yet with this confession on their lips the promoters are not one whit ashamed. This is not the first error that has been made in printed documents concerning this remarkable invention. The papers which were handed to the party at Halifax were full of glaring mistakes, but the excuse was that many of the statements had been transmitted by telephone. We hear that a pamphlet was issued, giving the names of the journals which had noticed the scheme. Now, investors might easily be led to imagine that the journals mentioned had spoken favourably of the scheme; but how reliable this list is may be gathered from the fact that the Electrical Review and *Engineering* are included. The only reasonable conclusion that one can make from the *Pall Mall* correspondence is that the statements made by the promoters are careless, and are not likely to influence level-headed investors. We give

a few brief extracts from the criticism of a specialist, and to be quite fair, we give Mr. Glaskin's reply:—

"As an example of how answer should not be made, I may take the reply of Mr. Glaskin on the tests and results alleged to have been obtained with Bradford refuse. It was stated that 'an analysis of the figures leads one to the conclusion that the *combustible matter* in the refuse must actually be of higher calorific value than even *good coal*.' To make it clear to Mr. Glaskin the important terms are put in italics. The latter gentleman replied to this: 'How can this be when the vendor's statement is that 3 lb. of *refuse* is only about as good as 1 lb. of *coal*?' This is mere quibbling. The terms 'refuse' and 'combustible matter' are not synonymous; the former includes the clinker, or incombustible matter. In the test of Bradford refuse the 'total weight of refuse' is given; so is the 'clinker.' Now if we look up Codrington's report to the Local Government Board, we find that Bradford house refuse contains 47 per cent. of moisture. This and clinker have to be deducted from total refuse consumed, and it leaves a figure representing the true fuel or combustible material in pounds which evaporated the weight of water recorded. On working this out I find that Bradford house refuse has for its combustible portion a value some 20 per cent. higher in thermal units than good steam coal. Does Mr. Glaskin understand the point now, and will he give a plain, definite reply? It is claimed that the Livet process requires no drying or treating operation, so the moisture at least must be present in that refuse. Then does Mr. Glaskin recognise that Mr. A. R. Binnie, the engineer to the London County Council, and an engineer whose opinion carries great weight, has stated that refuse to coal in its steam raising value is as 1 to 5—not as 1 is to 3?

"Then the point arises—and it is a vital one—who are the experts who have made trials? Are they recognised authorities in this branch of work, having carried out trials before, and how were the trials conducted? Who are the independent experts? Do they know what boiler testing really means? and have they obtained results which will substantiate the 3 to 1 ratio and water evaporation claimed in the prospectus?

"Secondly, how is it that members of the public who visit Halifax are told that the boiler there is capable of steaming up to 350 H.P. with refuse, or 1,000 H.P. with coal? It is hardly likely that the Livet people have ever faced what it means to put into print that the boiler is really capable of evaporating 20,000 lbs. of water per hour, say, at 50 lbs. pressure, which is the only thing that statement can mean, unless it is utter verbiage. Even on the smaller basis of 600 H.P., as mentioned by Mr. Glaskin, it means a very big boiler indeed. Will Mr. Glaskin therefore say why that boiler should be credited with such figures? Has it ever been tested to a duty of even half that corresponding to the horse-power given it by the company's officials? and if not, how is its size arrived at? Then comes the awful statement of 250,000 C.P. to be dealt with. Mr. Glaskin explicitly states in his letter that this refers 'to the power developed by the boiler.' Now, why has it been found necessary to cloak facts in such a disguise? As it is not usual to specify a boiler's size except by its maximum evaporation per hour with good coal, it seems that some other reason was present in the minds of the Livet Company when they arranged to measure the size of their boiler in *candle-power*. And they have an engineer and consulting engineer, too. But let us examine what this wonderful boiler will do. 600 H.P. is equal to 600 × 746-1,000 kilowatts, or say 450 kw., and we get 250 C.P. to the kilowatt—that is, 450 × 250, or 112,500 C.P. from good lamps, with no allowance whatever for losses in engines, dynamos, mains, &c., a condition, it is needless to say, never to be hoped for in our wildest dreams. But after all, the point only needs to be mentioned for common-sense people to see that something else is required to account for (*a*) the statement that the boiler is capable of steaming continuously at the rate of 600 H.P., and (*b*) that the size of the Halifax plant should be given to the public in electric candle-power when the boiler only was referred to, and the electric plant at Halifax is really only of 8,000 C.P. This is the second point for Mr. Glaskin and his colleagues.

"Thirdly, a personal remark: Will Mr. Glaskin let us know if he has ever made boiler trials before coming on the scenes at Halifax, and if so, on what scale and where? Also, does not Mr. Glaskin know that *Engineering* holds the first place in the technical press, and that he has not replied to their direct request for information; further, that of the leading technical papers only the *Engineer* and the *Electrician* took the Halifax show—it is nonsense to call it a trial—seriously, and the former not at all warmly, while the latter is not an engineering paper at all, but a scientific journal, while *Engineering*, the Electrical Review, *Industries and Iron*, and *Lightning* all took the company to task for an attempt to put forward assertions as if they were facts—no ground being given to support the statements made? The above is budget No. 3."

In his letter, Mr. Edwin Glaskin, the consulting engineer, replies to "Specialist's" criticisms as follows:—

"One-third of Bradford refuse consists of refuse from ash-tubs, and the remaining two-thirds of privy and ash-pit refuse combined (see Codrington's report, page 20). The test quoted was made with the former.

"'Specialist's' point No. 1 is a question neither for an anonymous writer to ask, nor for Mr. Glaskin to take the liberty of replying to.

"Point 2. The report commences by stating that 20 lbs. of water evaporated per hour would be the standard of measurement for one horse-power in all the calculations, and by that standard the power of the boiler at Halifax is measured. As to the 'awful statement,' it was too apparently awful to be taken for anything but what it was, namely, a printer's error, as the report states 'that the capacity of the installation at Halifax is equal to 100 electrical units when burning refuse.' The horse-power being taken as representing 746-1·70 kilowatts.

"3rd. 'A personal remark.' Anonymous 'Specialist' has evidently forgotten himself.

"4th. Mr. Glaskin has, and always has had, the very highest regard for the opinion of *Engineering* from its first issue, and cannot permit an anonymous writer to change those relations.

"5th. Mr. Glaskin repeats his statement as to Newcastle, and resents the suggestion of an attempt to teach."

More important answers it is difficult to conceive.

The House-to-House Electric Supply.

The annual report of this company shows that the revenue account gives a credit balance of £4,231, which, with the addition of a balance and another small sum, makes a total of £4,796. After putting £1,300 towards depreciation fund, suspense renewals account, and the reduction of preliminary expenses, a dividend of 7 per cent. is to be paid on the cumulative preference shares, and the balance of £43 is carried forward. It is satisfactory to note the increase in profits during the past three years. In 1891, with 19,000 lamps, they were £2,250, and at the end of 1893, with 28,000 lamps, the profits stood at £4,756. Another pleasing feature is that while the profits of 1893 show an increase of £1,421 over these for 1892, the working expenses show a decrease of £19. Apparently the demand for current still continues, for we notice that another engine and alternator has been laid down which brings the present capacity of the station to 45,000 8-C.P.

The analysis of the accounts shows the cost of generation to be as follows:—

	1891.	1892.	1893.
Total capital expenditure ...	—	—	£77,177
Number of units sold	—	—	358,506
Number of lamps connected ...	19,388	23,700	28,429
Revenue from sale of current ...	£8,328	£10,688	£11,126
Average price obtained per unit..	—	—	7·44d.

Cost of production.	£		Per unit.
Coal	2,881		1·93
Oil, waste, water and engine room stores	676		·45
Salaries and wages at generating station	1,936		1·30
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	567	Works cost 4·06	·38
Rates and taxes	459		·31
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,114		·74
Depreciation of buildings and plant account	1,300		·87
Renewal fund account	nil		—
Total	£8,933		5·98d.

Revenue.			Average price obtained per unit.
By sale of current	11,126	0 0	7·44d.
Meter Rents	844	0 0	—
Sale of Lamps	—		—
Total	£11,970	0 0	7·44d.

Total cost per unit (exclusive of depreciation and renewal accounts), 5·15d.; works cost, 4·06d.

New Prospectuses.

Of the new prospectuses to be noticed this week, the most important is that of the Charing Cross, Euston and Hampstead Railway Company, which is authorised by its special Act of Parliament to construct (under the Greathead system) and work an underground electric railway connecting Charing Cross with Euston and Hampstead, and comprising a line about five miles in length, commencing in the Strand, at or near Charing Cross, passing underneath King William Street, Charing Cross Road, Tottenham Court Road, Hampstead Road, Haverstock Hill, and terminating at the junction of High Street with Heath Street, in close proximity to Hampstead Heath, including a branch from the Hampstead Road terminating at or near Euston Station, and forming a communication between that station and Charing Cross. Stations will be constructed at or near Charing Cross, Oxford Street, Euston Road, Euston Station, Mornington Crescent, Chalk Farm, Belsize Park, and Hampstead Heath. The issue is now announced of the authorised share capital of £1,416,000, in £10 shares. The application list opened yesterday, and closes on or before Tuesday next for town and country. The prospectus states that it is proposed to equip the railway for a 2½ minute service each way, with a seating capacity of 200 passengers per train, and it is estimated that the profits would be sufficient to pay over 6 per cent. on the share capital.

No contract has been made for the construction of the railway, but tenders have been obtained from several eminent firms of contractors The engineers to the company are Sir Douglas and Mr. Francis Fox, and Mr. J. H. Greathead.

AN 1893 COMPARISON OF SOME SUPPLY COMPANIES.

	Capital expended.	Units sold during 1893.	Lamps connected.	Revenue from sale of current.	Average price obtained per unit.	Works cost per unit (exclusive of rent, rates and taxes).	Total cost of producing a unit (exclusive of depreciation and renewal.)
Bath Electric Lighting Company	£47,453	65,586	7,070	£5,598	...	...	...
Birmingham Electric Supply Company	£72,666	352,096	10,223	£9,835	6·7d.	2·06d.	3·58d.
Charing Cross and Strand Electricity Supply... ...	£211,200	...	34,570	£20,827	...	...	...
Chelsea Electricity Supply Company	£99,483	402,848	40,665	£13,078	7·7d.	2·78d.	4·44d.
City of London Electric Lighting Company, Limited	£799,610	1,741,099	65,341*	£37,156	7·56d.*	3·096d.	3·24d.*
Eastbourne Electric Supply Company	£37,950	124,663	8,454	£4,560	8·7d.	3·75d.	5·23d.
House-to-House Electric Light Company	£77,171	358,506	28,429	£11,126	7·44d.	4·06d.	5·15d.
Kensington and Knightsbridge Electric Lighting Co...	£174,260	724,308	64,529	£20,746	6·8d.	...	3·6d.‡
Liverpool Electric Supply Company	£214,222	873,325	25,000	£24,735	6·9d.	2·07d.	2·73d.
Newcastle and District Electric Lighting Company ...	£44,278	388,422	4,000 (10 C.P.)	£6,880	4·25d.	...	3·01d.‡
Newcastle-on-Tyne Electric Supply Company... ...	£45,715	360,467	18,150	£6,161	4·08d.	2·02d.	2·78d.
Notting Hill Electric Lighting Company	£78,480	107,580	12,000	£3,507	7·81d.	3·84d.	7·4d.§
Oxford Electric Light Company	£58,107	103,895	7,012	£3,141	7·2d.	2·49d.	5·7d.
St. James's and Pall Mall Electric Light Supply ...	£211,029	...	...	£29,766	...	...	...
Westminster Electric Supply Corporation	£400,000	1,704,605	131,565	£41,949	5·9d.	2·27d.	3·44d.
Yorkshire House-to-House Electricity Company, Ltd.†	£45,270	130,068	...	£3,771	...	...	5·1d.

* Refer to private supply. † Eight months' working. ‡ Includes depreciation. § Includes special changes.

Another company which we have to notice is the County of London and Brush Provincial Electric Lighting Company, Limited, which has been formed with a share capital of £800,000, divided into 40,000 preference and 40,000 ordinary shares of £10 each; in addition, the directors have power to raise £400,000 on debentures. The company was registered in June, 1891, for the purpose of undertaking the supply of electricity in certain districts in the County of London and in the United Kingdom where capital may be profitably employed in electric supply. It has obtained provisional orders for the districts of the united parish of St. James and St. John, Clerkenwell, Parish of St. Luke, District of the Wandsworth Board of Works, and the Parish of St. George-the-Martyr. In addition to operations within London districts, the company will undertake the erection and equipment of power stations in provincial towns. Further information will be obtained from page 4 of the advertisement supplement.

It will be seen that the company is apparently going to carry out an extensive programme, but there is reason to expect that the operations of the company will be safe and remunerative.

Rockhampton Gas and Coke Company, Limited.

The directors' report for the half-year ended December 31st, 1893, states that notwithstanding the general depression that has prevailed, necessitating economy on the part of the company's customers in their use of the gas and the electric light, the profit is greater than for the corresponding half of last year. The gas operations show a profit of £2,606 13s. 9d. The electric light operations show an actual loss of £21 9s. 4d., to which is added £294 2s. 11d., interest upon the capital invested in the electrical plant and buildings, making a debit balance of £315 12s. 3d. The net profit arising from the whole of the company's business is £1,691 1s. 6d. The lighting of the Fitzroy Bridge with powerful electric arc lamps, referred to in the last report, is now in operation. Numerous applications from business people have been made for high power arc lamps for outside illumination, and the directors are importing suitable lamps for this purpose. A section of the company's amended act provides that the retention of the power to supply Rockhampton with the electric light is dependent upon the company commencing operations and installing the light to the satisfaction of His Excellency the Governor-in-Council, and of the Council of the Municipality of Rockhampton, within five years of the date of the passing of the said Act. The directors are pleased to be able to report that His Excellency the Governor has intimated his satisfaction and approval of the work done by the company in this direction, and that the Rockhampton Municipal Council has passed a special resolution expressive of its entire satisfaction of the manner in which the light has been installed. The special conditions of the Act having therefore been complied with, the company's powers in respect of electric lighting in Rockhampton and North Rockhampton, are now finally confirmed. The directors, after careful consideration, are of opinion that the debit balance of the electric light operations can fairly be written off the general reserve fund, and they recommend this being done. They also recommend that a dividend at the rate of 10 per cent. per annum, amounting to £1,997 4s. 4d., be paid out of the profit arising from the gas operations for the half-year. The profit and loss account which deals with the electric light operations, is as follows:—

Dr.	£	s.	d.
To Generating electric current	516	7	10
„ Maintenance	113	17	8
„ Management	73	14	4
„ Insurance	6	10	0
„ Interest	294	2	11
„ Rates and taxes	37	13	3
„ Advertising, printing, &c.	16	2	8
„ Public lamps	11	13	9
	£1,070	2	5

Cr.	£	s.	d.
By Electric current sales	542	5	9
„ Sundries	55	13	0
„ E.L. fitting account	156	11	5
„ Balance	315	12	3
	£1,070	2	5

The Chatham and District Electric Lighting Company.—The directors report that they have now passed through the most difficult part of their career, and can see their way to earn large profits. Customers and lights have increased, and nearly every customer has taken up the meter in preference to fixed contract, and expressed their satisfaction with the system. The company could declare a dividend of 2½ per cent., but the board have decided not to recommend a dividend until next year.

Waterloo and City Railway Company, Limited.—In reference to this company, the applications for shares are in excess of the number required, and letters of allotment and regret have doubtless by this time been posted.

St. James's and Pall Mall Electric Light Company.—We are informed that the whole of the £30,000 4 per cent. debenture stock recently issued by this company has been applied for and allotted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 25th, 1894, amounted to £792; week ending March 26th, 1893, £859; decrease, £67; total receipts for half-year, 1894, £11,191; corresponding period, 1893, £11,271; decrease, £80.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 23rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,735.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, March 20th.	Closing Quotation, March 28th.	Business done during week ended March 28th 1894. Highest.	Lowest.
184,500/	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	100 —103	100 —103	...	...
1,134,640/	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	42 — 44	42 — 44	...	...
2,932,680/	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	77½— 78½	78½— 79½	79½	78
2,932,680/	Do. do. Defd.	Stock	...	...	...	7¼— 7⅝	7¼— 7⅝	7⅝	7
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6¼% §	11¾— 12¼xd	11⅝— 12¼	12 1/16	11⅝
18,700/	Do. do. 5 % Bonds	100	...	...	...	99 —102	99 —102	...	...
75,000/	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	1½— 2½	1½— 2½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	146 —150 xd	146 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	12⅜	12¼
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	2½ 3½	2½— 3½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	9½ 9½	8¼— 9½	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	10⅜— 10⅝	10½— 10⅝	10 1/16	10½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	14¾— 15	14¾— 15	15	14⅞
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16 — 16½	16 — 16½	16	...
105,900/	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —109	107 —110	107	...
1,294,100/	Do. 4 % Mort. Deb.	Stock	...	...	...	113 —116	114 —117	115½	115
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	...	15¼—15½	15¼— 15½	15½	15 7/16
62,700/	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
222,800/	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000/	Do. 4 % Deb. Stock	Stock	...	...	...	112 —115	113 —116	...	...
95,100/	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100/	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000/	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	103 —106	104 —107	...	...
200,000/	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5½% §	4½% §	4⅜% §	8⅜— 8⅞	8⅜— 8⅞	8⅞	8⅜
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15 — 15½	15 — 15½	15½	15
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	...	21 — 22	21½— 22	...	...
200,000/	Do. do. do. 5 % Debs.	100	...	...	...	104 —107	104 —107	105	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	43 — 45	43 — 45	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000/	Do. do. 6 % Debs.	100	...	...	...	105 —108	106 —109	108¼	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	⅛— 1⅛	⅛— 1⅛	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4½— 4⅝	4½— 4⅝	4⅝	4 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	14½— 15½	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5¼— 5½	5⅜— 5⅝	5 7/16	...
925,017/	Do. 4½ % Deb. Stock Prov. Certs.	...	...	...	...	114 —116	115 —117	117	115¾
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
220,000	Oriental Teleph., Ltd., 80,001 to 300,000; 11s. paid	1	2½%	3⅛%	4¼%	... ...xd	... ...	...	...
100,000/	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5¼— 6⅛	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	113 —118	113 —118	...	...
58,000	United River Plate Tel-ph., Ltd.	5	...	...	...	1½— 2	1½— 2	...	...
146,370/	Do. do 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900/	Do. do. do. 5 % Debs.	100	...	...	...	98 —101	98 —101	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2¼— 2⅜	2¼— 2⅜	...	...
150,000/	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	98 —102	99 —103	102	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	7⅞— 8¼	7⅞— 8¼	7⅞	7⅞
33,129	Do. do. do. 5 % Cum. Pref.	7½	...	...	...	6 — 6¼	6 — 6½	6	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	2 — 2⅛	2 — 2⅛	2⅜	2
178,200/	Do. do. do. 6 % Debs. "A," 1910	100	...	...	...	105 —108	105 —108	...	...
222,700/	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	105 —108	105 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1⅛— 1⅜	1⅛— 1⅜	...	...
34,563	Do. do. do. 6 % 1st Pref.	10	...	...	...	10 — 10½	10 — 10½	...	...
4,669	Do. do. do. 6 % 2nd Pref.	10	...	...	..	8½— 9½	8½— 9½	9½	...
80,000/	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	106 —109	106 —109	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	...	...	...	113 —118	113 —118	...	...
169,000/	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4 — 5	4 — 5	...	...
40,000	Cityof London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	12 — 13	11½— 12⅛	12⅝	12⅛
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13½— 13⅝	13½— 13⅝	13½	13½
19,900	*Electy. Supply Co. of Spain, 101 to 20,000	5	...	...	...	... ...	... ...	...	...
30,000	†Liverpool Electric Supply, £4 10s. paid	5	...	...	...	5½— 5⅝	5 7/16— 6⅛	5⅝	5⅝
15,000	Do. do.	5	4½%	5 %	5 %	6¼— 6⅜	6 7/16— 6 9/16	6½	6½
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000	10	1 %	2 %	...	8½— 9	8¼— 8⅝	8⅝	8¼
100,000/	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	106 — 109	106 —109	108	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4¼— 5⅛	4½— 5⅛	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	6¼— 6⅝	6¼— 6⅝	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8½	8 — 8½	8 7/16	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	...	3½%	4 %	5⅜— 6¼	5⅜— 6¼	6	5 15/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, March 20th.	Closing Quotation, March 28th.	Business done during week ended March 28th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅞ — 3⅛	2⅞ — 3⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅜ — 2⅝	2⅜ — 2⅝	2¼	...
125,000*l*	Do. do. 4½ % Deb.	Stock	...	...	...	108 —111	108 —111	110½	109
630,000*l*	City and South London Railway	Stock	...	⅝%	⅝%	27 — 32	27 — 32	...	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3½ — 4	3½ — 4	...	...
50,000*l*	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	97 —102	97 —102	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼ — ⅜	¼ — ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1¼ — 2	1¼ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	½ — ¾	½ — ¾	...	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	½ — ¾	½ — ¾	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
12,134*l*	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. do 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23⅞	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	101 —103 xd	...	...
11,334	International Okonite, Ltd., Ord., 22,667 to 34,000 ...	10	5 % §	...	...	1 — 2	1 — 2	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	5¼ — 5½xd	6⅞ — 7½	7	5
6,295	† Do. do. Pref., £8 paid	10	...	...	...	9 — 9½xd	9⅜ — 9⅝	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2½	2 — 2½	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	39 — 41	40	39⅞
150,000*l*	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	... ...	... ...	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—5⅝.
Brush Company, 4½ % Debenture Stock, issued at 1 % premium, 106—108.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅞—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6⅛—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6½—6⅝.
Do. do. £3 10s. paid, 4½—4⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

REVIEWS.

*Electric Traction.** With 156 woodcuts inserted in the text. By Giulio Martinez. Milano: Ulrico Hoepli. 1894. 8 vo., pp. 347.

After an introduction explaining the development and the present importance of electric traction, the author enters upon the fundamental principles of the electric transmission of mechanical energy. He describes the ideal reduced to its simplest principles, and the ideal transmission of energy. Then he passes to consider real machines. The conditions above laid down are unfortunately not all capable of being realised in practice. The writer proceeds to consider self-excitation in shunt and in series, characteristic curves, and the acting conditions for the dynamo, the maximum field of transmission, and the energy expended on the line. He maintains that Thomson's rule is not always applicable without caution. He admits that electric transmission with alternating currents has latterly assumed great importance, though it has certain inconveniences, and motors with polyphase currents seem more important. The Lauffen Frankfort transmission has proved a triumph for this system.

However, neither polyphase currents nor alternating currents have yet any practical application in electric traction in which direct currents of a moderate potential are exclusively used.

In the second chapter we find an examination of the practical advantages of electric traction. The author considers that all the elements for a fair comparison between steam traction and electric traction are not yet available, especially as regards economy. He emphasises the fact that steam locomotives have the disadvantage of having to carry a heavy dead weight of water and fuel, that in urban traffic they are noisy, dangerous, and a nuisance on account of their smoke. He considers that the electric locomotive has the advantage over the steam locomotive in simplicity and lightness, and points to the success of the *City and South London Railway*. Signor Martinez holds that the use of accumulators presents a prospect of success. He examines the relative advantages and defects of motors in series or shunt, and the use of motors as brakes.

In Chapter III. we come to electric carriages and the various systems for reducing the velocity of the motor. The author discusses the scheme of the Edison-Sprague circuits and regulators, electric heating and lighting in trains, the passage of the current to earth, and the removal of snow.

The fourth chapter gives us the two systems of distribution in series and in parallel, with the advantages and defects of each, and a notice of the three-wire system.

In Chapter V. the author enters upon the various systems of leads, aerial and underground. He describes the conductors of Bentley and Knight, those at Blackpool, at Buda Pest, at Chicago, and those which were used at Northfleet. He considers that the principal, if not the sole, question is that of expense. He asserts with truth that aerial distribution costs much less. But it seems to us that he does not take into due consideration the inconveniences and dangers of overhead wires in case of snow, of tempests or conflagrations.

Chapter VI. deals with central stations, the use of water as a source of motive power, the power of the machines, accumulators at a central station, and protection from lightning. This last point is illustrated with figures of conductors. Of these appliances, four main types are described. To the first class belongs the well-known apparatus of Elihu Thomson, the second category includes various models devised by Winsor and Wurst, of the Westinghouse Company. The third class, with a fusible wire, has as its type the recent model "Fulmen." The appliances of the fourth class are founded on many principles. That of Wirt is taken as a characteristic specimen.

* *La Trazione Elettrica.*

In Chapter VII. the author considers the economy of electric traction. Here a definite conclusion has not been reached, but the author considers that the new electric underground line in London has furnished new arguments in favour of electric traction. He quotes Crosby to the effect that an electric locomotive, capable of transmitting motion to the wheels with an efficiency of 80 per cent., will be more economical than a steam locomotive with a yield of 90 per cent. for all speeds exceeding 160 kilometres.

Attention is called to the simultaneous employment of electric plant for light and motive power purposes.

The last chapter is devoted to traction by means of accumulators. Such traction remains applicable, commercially speaking, in some cases where special conditions are unfavourable to direct transmission.

Several useful appendices conclude the work, such as instructions for the personnel of the electric carriages and for the passengers; new official regulations for installations transmitting electric energy; notes on the installations of electric railways existing in Europe; on American installations; on projects for electric lines for the highest speed, &c.

The utility and the value of this work are not to be called in question, but we wish that some of the illustrations had been more carefully executed.

The Inventions, Researches, and Writings of Nikola Tesla, with Special Reference to his Work in Polyphase Currents and High Potential Lighting. Published at the office of the *Electrical Engineer* of New York.

This is a record of the pioneer work done by Mr. Nikola Tesla through the wide scope of his inventions. It is written by Mr. Thomas Commerford Martin, one of the able editors of the New York *Electrical Engineer*, and is characterised by the number and excellence of its facts and the lucid manner in which they are set forth. In the first part, the book outlines the distinctive features of alternate current motors and transformers, and the associated work upon polyphase currents, demonstrating the application of the "rotating field" principle to innumerable possibilities. It discusses the evolution of the "multiphase" system, with its various ramifications; the broad idea of motors employing currents of differing phase in the armature with direct currents in the field; the notion of an armature with a body of iron, and coils closed upon themselves; "synchronising," and "torque" motors; the adaptation of old forms of generators and motors to Tesla work; and the use of condensers in field and armature. These, however, are but a small number of the distinguished inventor's successes to which the book bears testimony.

Mr. Tesla believes he is the first to operate electromagnetic motors with alternating currents by producing a progressive movement, or rotation, of their poles, or points of greatest magnetic attraction, by the alternating currents, until they have reached a given speed, and then, by the same currents, producing a simple alternation of their poles; or, in other words, by a change in the order or character of the circuit connections to convert a motor operating on one principle to one operating on another. He has further provided an arrangement whereby the torque, at the start, may be given any required relationship to the tendency to synchronism; and he has shown how to adapt alternating current motors to efficient running, on the circuits of present-day use, in which the generators have a forbidding frequency. The respective *pros* and *cons* of "synchronising" and "torque" motors are clearly stated, and there follows Mr. Tesla's method for obtaining a general-purposes machine by combining a "synchronising" motor with a "multiple circuit" or "torque" motor—by the latter he brings the first up to speed, and then either throws the whole current into the synchronising motor or operates them conjointly. Mr. Tesla's work in this regard has been so exhaustive that the book can scarcely be expected to supply more than an outline of his researches, and here it is impossible to do more than hint at them; whatever the future may show us in alternating current motor usage, this record will probably contain the germ from which the perfected machine will grow.

The second part of this volume is likely to be more popularly esteemed than the first, for it classifies the remarkable phenomena connected with the Tesla effects with high-frequency and high-potential currents, or what he regards as the inter-working of electrostatic molecular forces. These researches have been, in part, already published in the accounts of Mr. Tesla's lectures before the "Royal Institution," The Institution of Electrical Engineers," the "American Institution of Electrical Engineers," the "Franklin Institute," and the Electrical Congress of Chicago; but we are glad to have the results before us in collected form, as indicating at one view the vast range of thought and dominant energy of the man; it goes far to inspire the spirit of invention, and the habit of co-ordinating facts with fancies, and submitting them to experiment.

The comparatively small physiological effect of the high tension discharge is, to some extent, attributed to the condenser action between the distributed tissues; but, in the case of an induction coil with a great many turns, it is pointed out that the harmlessness is due to the fact that, on account of the great impedance of the coil, but little energy is available for the experimenter's body.

In the short biography with which the book opens, we are told that Nikola Tesla was born in 1857 at Smiljan, Lika, a borderland of Austro-Hungary. His family is an old and representative one among these Switzers of Eastern Europe; his father was an eloquent clergyman in the Greek Church. His mother was possessed of great ingenuity and delighted herself in the design of looms and churns. Nikola was educated at Gospich for a few years, afterwards going to Carstatt, Crotia. He graduated in 1873, and then entered the Polytechnic School at Gratz. Finally he crossed the Atlantic and joined issues with Edison, but he has since been connected with a company intended to make and sell an arc lighting system based on some of his inventions. A capital portrait of Tesla is given in the frontispiece, an excellent likeness, and as we knew him.

Illustrated and Priced Catalogue of Patent and Improved Tools and Machinery, &c. Buck & Hickman, 280 and 281, Whitechapel Road.

This is a thorough business like catalogue, and is something more than a mere price list, as it might be almost called a treatise detailing the various descriptions of tools which are available for mechanical work. Though the compilation of the book must have involved very considerable expense, it will prove money well laid out.

Electricity in the Service of Man. By R. Wormell, D.Sc., M.A. (From the German of Dr. A. R. von Urbanitzky). Revised and enlarged by R. M. Walmsley, D.Sc. London: Cassell & Co., Limited.

In revising this book Dr. Walmsley has excised 120 pages of the previous issue and has added 200 new pages. The additions consist chiefly of a description of the recent work of the Thomsons, Hertz and Tesla, and a section on "Public Supply Central Stations" has also been added. Electric transmission of power, electric furnaces, telephony, and multiplex telegraphy, are more extensively treated than in the old editions. The more one examines the book the more one is struck with the immense amount of information which it contains. Here and there we come across inaccuracies; thus, for example, on page 875, we have the chemical copying telegraph of Bonelli attributed to Bain, whereas, as a matter of fact, as is well known, Bain's apparatus was only used to transmit dots and dashes. For a wonder the "Minotto" cell is correctly spelt. We may mention that the form of trough Daniell battery described on page 423, and stated to be used by the Post Office, was discarded 10 years or more ago. Provided the work is kept up to date, this 3rd edition will not be the last, as it is undoubtedly a valuable production, especially as a book of reference.

Spon's Architects' and Builders' Price Book, 1894. By W. Young. 21st Edition. London: E. & F. N. Spon, 125, Strand.

The value of books of this kind can hardly be overestimated, especially when they are well compiled, as is the case with the work in question, and, moreover, are got up in Messrs. Spon's well-known excellent style. The principal additions include a chapter on electricity, with complete specifications and estimates of electric lighting installations

carried out by the author, lightning conductors, electric bells, &c. Probably no two people could be found who would agree as to the proper terms of an electric light installation specification (or, for the matter of that, to any specification), but though those given by Mr. Young are no doubt, in some respects, open to criticism, they are satisfactory as general types. A little more emphasis might with advantage have been laid upon the necessity of using none but the very best quality of insulation for house wiring.

VARIOUS SYSTEMS OF UNDERGROUND MAINS AND METHODS OF LAYING SAME.*

By S. V. CLIREHUGH, Assoc.M.Inst.C.E.

(*Concluded from page* 355.)

I think that other things being equal, the paper insulation has an advantage from the fact of its cleanliness in jointing. The power of paper as a dielectric for resisting disruptive discharges is very high, and ¼-inch radial thickness of insulation has been found sufficient to withstand a pressure of 20,000 volts, which I believe no other dielectric of this class would stand.

No paper on this subject could pass without a word of reference to the mains invented by Mr. Ferranti. When Deptford was started, and the idea of transmitting energy at a pressure of 10,000 volts was seriously entertained, no cable could be found which was likely to be able to withstand what was then considered an almost impossible pressure. Mr. Ferranti therefore invented his well-known main, a sample of which may be seen on the table, and it is noteworthy that after trying every conceivable form of dielectric, he at last decided on paper as being most calculated to withstand the disruptive discharge.

The first of these mains was laid when I was with the London Electric Supply Corporation, some six years ago, and with the exception of damage caused by external injury, they have been running very satisfactorily ever since. As these mains have now been quite superseded by the British Insulated Wire Company's manufacture, which remove the principal difficulties in connection with their use, I need not trouble you with a description of their manufacture, which will be found in most text books.

We have still one more cable under this class to discuss, viz., Brook's oil insulation system. This system resembles the lead covered fibrous cable system, as will be seen. The cables are sent out heavily braided, as will be seen from the samples; this braiding simply serves to keep the conductor from mechanical contact with the pipe.

The iron pipes in which the jute-covered conductor and oil are contained are laid underground, and at the highest point in the pipe line a C.I. tank is fixed, which serves as an oil reservoir, and ensures the pipes being kept full of oil. The inlet to the boxes through which the cables pass are provided with glands, which thus allows the box to be emptied for testing purposes and making fresh connections.

Those who have had anything to do with the heavy resinous oil used on this system will appreciate the difficulty of getting the oil out of the box, and the horrible state of mess the jointer would be in. When the pipes and boxes have been laid and all joints made tight, the cables are drawn in. To prepare them for this stage, the braided cables are placed in a portable tank containing fluid insulating material at a temperature of about 300° Fahr. for a sufficient length of time to expel all moisture from the fibrous covering. They are then drawn into the iron pipes, and oil is forced in to fill up all the spaces. This system might be suitable for feeders, but I should think it difficult to work on a system of distributing mains.

I have unfortunately no figures as to the cost of this system.

I have so far endeavoured to describe to you the various classes of cable which are suitable to be drawn into conduits, and to point out the relative advantages and disadvantages of each, from which you will see that no hard or fast rule can be laid down; but each case must be governed a great deal by local circumstances.

Armoured cables may be dismissed very briefly, the principal object in their use is their supposed cheapness, which, however, is overrated, as will be seen from the table. They may be of service in outlying districts, and possibly in some cases for feeders; but there are many drawbacks to their use, one of the principal ones being the difficulty of fault finding, as in any draw-in system, whenever the fault is arrived at within, say, 20 yards, that length of cable can be drawn out and examined at leisure, whereas with an armoured cable you have to open many yards of ground before you actually arrive at it.

We now come to the last class of mains, namely, bare copper in conduits. Messrs. Crompton & Co. are the great exponents of this system, and you will see numerous samples indicating their system on the table. Much might be written on this class of mains; but as this paper is already of considerable length, it will suffice to describe one system, viz., the Crompton, as showing the principle, the other systems merely vary slightly in detail. The bare wire system, it need hardly be said, is suitable only for low tension.

The culvert consists of a concrete trench, laid under the footway. The culverts are constructed of cement concrete, the wall in no case being less than 6 inches thick, and the bottom 4 inches. They are covered with York stone, bedded in cement, and the culverts are rendered inside with cement, thus making it thoroughly waterproof. Boxes are built every 15 yards along the trenches, and these are the only places in which the cable is supported, so that the insulators are always open for inspection.

The insulators are mounted on oak crossbars (which are mounted on the concrete about 2 inches off the bottom), and are made with a notch in the top on which the conductors rest. The culverts are connected where possible to the main drains. It might be thought that a film of moisture would collect on the insulators, thus giving rise to considerable leakage; the electrolytic action of the current, however, is said to be sufficient to resolve this moisture into its two component gases.

We seem here to have a system which combines most of the desired qualities in a system of mains; however, this has its drawback, like all others. Firstly, in many of our great cities it is impossible to find room for this class of conduit, and then recourse is had to insulated cables. Secondly, a water main bursting might possibly cause a stoppage of the supply; this, however, is not very likely to happen.

Thirdly, gas is apt to accumulate in the conduit, giving rise to explosions; it is, however, less likely to get into a watertight conduit than into a system of iron pipes, where there is no attempt made to keep out the water. Whether bare conductors are more likely to ignite the gas is a much debated question. Only recently two of the technical papers had an article on the subject. One said it is easy to see how the gas gets into the conduits, but what fires it; the other, however, wondered how the gas got in, but understood how once in, it was fired. Personally, I am inclined to believe that most explosions occur from lighted matches, candles, &c., being introduced into the boxes. As regards the life of this culvert system, it seems that we have at least got hold of materials which have stood the test of time, viz., oak, concrete, and copper.

I should have liked to mention some points connected with the use of concentric and triple concentric cables, and the effect of an alternating current in increasing the virtual resistance of the conductor, as also the question of dry core telephone cables, but, unfortunately, time does not permit.

* Paper read before the Northern Society of Electrical Engineers, Manchester, March 12th, 1894.

At the ordinary general meeting of the members of the Northern Society of Electrical Engineers, held on Monday, last week, at the Palatine Hotel, Manchester, Mr. G. E. Preece, the Vice-President, in the chair, the discussion which followed the reading of this paper, and that of Mr. Rider, published on March 16th, was taken upon both the papers.

Mr. Wordingham said what they chiefly looked for was durability, and this they secured with India-rubber. With regard to rubber cables, if the joints were properly vulcanised, a fair insulation could be obtained.

Mr. Mountain, of Huddersfield, said a system of cables insulated with paper or fibre would be very good for a low tension station, but should not be used for high tension. When a cable was stranded into three, and twisted into spiral form, in the centre of those twists there must be a hollow space, and he thought there would be some difficulty as regards moisture.

Mr. Bourne did not advocate the use of paper for putting on cables; it was more for mechanical than for electrical reasons.

Mr. James Taylor said the difficulty of making rubber joints seemed to him over-estimated; the matter was very simple, although it needed care.

Mr. Connolly said that, as far as India-rubber was concerned, it had been used in some way or other as an insulating material for nearly 30 years, although in the early days of its use there had been numerous failures and troubles. He knew of cables now in use, covered with India-rubber, that had been made over 20 years ago, and these were still working with the highest degree of success. He had often thought that the course of experience in connection with electric lighting was more and more falling into "line" with the experience of the earlier days of telegraphy. That was to say, they were going from a lower class of insulation to a higher, and they were adopting, to a great extent, the "drawn-in" system, which was simply copying the system worked by the Post Office in connection with their telegraph wires. The only thing in which they did not, in electric lighting, follow the practice of the telegraphic world, was in the use of gutta-percha. He could not conceive of any permanent system of underground mains that did not consist of cables insulated with a waterproof material. With lead-covered cables, which were dependent entirely upon the lead for protection, there was the constant danger of a break in the lead, or trouble at the ends. They could hear on all hands of troubles with underground copper mains, not so much in Manchester, however, as in London, Paris and elsewhere, and it was constantly being forced upon him that they could not rely upon anything in a permanent way that did not consist of conductors insulated throughout; and although India-rubber was not the only material that could be used for the purpose, it seemed to be the only one that really satisfied every requirement. He did not know of any other substance possessing similar qualities, such as being water-proof, and not liable to melt with a temperature of, say, 160° F., and at the same time as durable as India-rubber.

Mr. Whiteley said his experience was that an intelligent workman could get into making rubber joints after one or two trials, and do the work satisfactorily.

Mr. Cowan remarked that in comparing the difference in cost of laying down the "drawn in" system of mains, and the armoured cables laid direct in the ground, he had obtained the net quotations from three or four of the largest firms in the country, and found that the cost of the "draw-in" system was 10 per cent. more than that

of the armoured system laid direct. With regard to Brooks's system of oil insulation, from his own knowledge of the method, he thought it was not very difficult to lay down, and it worked, on the whole, very satisfactorily.

Mr. Andrew said that between 40 and 50 years ago rubber had been vulcanised, and there were rubber cables 30 years old that were still in perfect condition.

Mr. Taylor said his experience in vulcanised rubber had extended over 25 years, and the material had been used for submarine work previous to that. Some of the cables that had been regarded as failures had been recently examined and found to be all right. With regard to joints, he did not think they should be treated too lightly. He had made vulcanised joints 20 to 25 years ago, in cables which were at present working in the German ocean, and his experience was that with care there need be no fear of them going bad, but the most important point was with respect to cleanliness, and the jointer should be properly trained before being entrusted to make a joint; and it should be insisted upon that the engineers should send their jointer to the manufacturer to be instructed in the method of making joints. There would then be no fear of them getting wrong.

Mr. Wordingham and other gentlemen also spoke with reference to making vulcanised rubber joints.

The discussion was then adjourned to the next general meeting of the society.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Discussion on a Paper by Mr. W. M. Mordey on "Parallel Working, with Special Reference to Long Lines," Thursday, March 8th, 1894.

Mr. Raworth said that the peculiar circumstance or phenomenon which Prof. Forbes had observed was not an alternating current effect at all, and no question of alternating currents was needed to explain it, nor for that matter did they want any electricity in the question whatever. They had on the occasion to which Prof. Forbes alluded, two dynamos working in parallel driven by two similar engines without load, with a governor connected together with one of the very thinnest connectors they could imagine. What happened under those circumstances? It hunted; every governor hunted. There was no such thing in the world as a governor that did not hunt, and there would not be until they got no friction; the centrifugal force must be enough to overcome the friction of the governor. That friction must be a definite amount and the speed must be a definite amount. When they said a governor did not hunt they meant that the changes were made so rapidly that they were never able to see the effect of the speed by the eye, but the hunting was there all the same. Now, what happened on that historic occasion at Messrs. Willans's works was this:—One of the governors was hunting; the steam would come on and carry the engine away a little faster, then the governor would shut down and the speed would drop. Of course, these variations were very small indeed, but still quite sufficient for the purpose. The engine which was leading had to pull the other after it through the very thin connecting link between the two motors. When it fell to exactly the same speed as the other, there was an exact equality of E.M.F. in both, and the speed went dead. That was repeated backwards and forwards. The same thing exactly would have happened if there had been two continuous current dynamos there, or if there had been no dynamos at all there. It was just the same as if they put one engine in front of the other and connected the two fly-wheels by a thin India-rubber band, when they would find the top of the belt slack and the bottom tight, or the bottom slack and the top tight, and that process would be continued in regular pulsations. The effect observed was a common mechanical effect, and had nothing whatever to do with the alternating current.

Mr. Sparkes said he wished to endorse Mr. Mordey's remarks about the running of alternators in parallel. The principal difficulty was to secure steam engines that would give them an equal turning moment. If they took an ordinary single cylinder engine, or even a compound, with a fly-wheel of ordinary proportions, and either had the engines connected on the same shaft or driven with ropes, on putting machines suitably proportioned into parallel, a certain synchronising current was needed to keep those machines in parallel. That current wholly depended upon the inertia of the moving parts, and if the change of speed varied very much during the revolution they found a very large current necessary to keep the two machines coupled immediately together. That was aggravated very often, as mentioned by Mr. Raworth, by governors. All governors hunted, and even when they had a governor with a very small amount of friction, they still required a sensible amount of synchronising current. This difficulty was got over by having more than one cylinder. When they took a compound engine they certainly got better results than by having a single cylinder. In coupling large cylinders together he thought it advisable that there should be at least two, if not three, high pressure cylinders working on the same crank so as to get a very equal turning moment, because the enormous strain placed on the armature of a machine, in order to correct the inertia of the moving parts, was not good for any engineering apparatus. If they put a very heavy fly-wheel on the machine, of course, they modified the amount of work done by the armature, but it was impossible in many cases to put on a sufficiently heavy fly-wheel to obviate the strain put on the armature.

Mr. Kapp said he had always been an advocate of having machines with a certain amount of self-induction. If they had a certain amount of self-induction, they got the soft and yielding gear between their two machines, whereas with machines with exceptionally little induction they got the hard blow, which might sometimes be the cause of the machines being ricked to pieces. He thought Mr. Mordey had not done himself justice. Most of the experiments were made on motors running light. In one or two cases there was a load mentioned, but it was a small load for the size of the machine. Had Mr. Mordey really treated the machines as they would be treated in a power transmission? That is to say, had he put on a 50-kilowatt alternator a mechanical load of 50 kilowatts, he would have found that it would have dropped out of step very much sooner than it did. As regards parallel running of alternators, it was not a question of the alternator, it was a question of the engine, and he could illustrate this best by an experience in Bristol. They had an engine with three cranks, which gave the most even turning moment, and they were provided with expansion gear, which was adjusted. They had to adjust the expansion of each cylinder separately, and it was necessary, or convenient, at different times of the day, to adjust the expansion, in order that the engine might always work with the greatest possible economy. As a man had not three hands, they could not all be adjusted at the same moment; one or two were adjusted at a time, therefore they got the turning moment slightly uneven; consequently the current went round; it was not quite even, and they saw it immediately on the instrument. As soon as they touched the expansion of one engine there was a slight change. This was an interesting explanation of what Mr. Sparkes had spoken of. As soon as they had adjusted all three, then the synchronising current went on again.

Prof. S. P. Thompson said it seemed to him that a good deal of the easy working of two engines working together might depend upon the fact of whether the steam supply was in common. Suppose a load on the station where two alternators were on omnibus bars. It would probably be desirable that both should contribute something. If they were run with governors, they would have to open the valves a little more, or something had to happen independently, as it were, on the two machines; whereas if they were fed from the same common valve, they might have a different condition and something more suitable for machines absolutely in phase with one another.

Société Internationale des Electriciens.

The ordinary meeting of the Société des Electriciens took place on March 7th, 1894, M. Raymond presiding. After several new members had been presented, M. Raymond spoke of an objection urged by M. Ducretet against the Bonetti machine without sectors, described at the last meeting; the idea had been published before. The president then read that part of the Giffard legacy which concerns the society, and afterwards presented to the society the list of candidates for the forthcoming elections: President for 1896, M. Potier; Vice-Presidents, Messrs. D'Arsonval, Sartiaux, Sciama; Secretaries, Messrs. Arnoux and Bochet; Treasurer, M. Clérac.

M. Picou then spoke of rapid methods of testing meters. With the service of the Controller's department, which was founded last year by the Syndical Chamber of Electrical Industries, we must find out very quickly whether a meter is correct or not. It is therefore impossible to make long and costly experiments, which would require that we should leave a certain number of lamps lighted for some time, and that we should follow the indications of the wattmeter. A very simple method for each meter has been found out, which enables a very easy test to be made without any unmounting. The principal meters used in Paris are the Frager, Thomson, Brillié, and Aron meters. In the Frager meter, a special needle on an outer dial marks tenths of a hecto-watt hour. The registering is periodic, we can therefore take several successive readings and, if we know the interval between each registration, deduce from them the mean power, which we compare with the power indicated by the wattmeter. In the Thomson meter we have merely to count the number of turns of the motor in a given time. From this we can very easily deduce the power at any given moment. We know, in fact, that 100 turns correspond to the registration of 1 hecto-watt-hour. We must also take into account the constant, which may vary from 1 to 25 in various types of meters. In the Brillié meter we may easily find out the power by applying the formula $P = W \frac{N}{T}$, in which P is the power in watts, W the maximum power, in watts, of the meter, N the number of divisions of a disc which passes before the index in T seconds. In the Aron meter, the different rate of two pendulums is registered; this difference is in proportion to the electrical energy expended. We have then only to estimate the difference of rate in a certain number of seconds. An advance of 14·4 beats corresponds to the registration of one hecto-watt-hour.

M. Picou then explained that the wattmeter can give indications that are correct within ½ per cent. We can, therefore, test the meters to within about 2 per cent.

At the end of the sitting, M. Hillairet described in a few words the influence of storms on the lines of transmission. He took three cases: the line struck directly in the middle, the line struck at the extremities, and the line influenced from a distance. The speaker confessed that he had not been able to find feasible explanations in many cases, and he asked the members of the society to collect as many facts as possible, so that general laws might be deduced from them.

NEW PATENTS—1894.

5,102. "A new or improved telephonic relay." G. Gillmore. Dated March 12th.

5,118. "Improvements in and connected with electro-locomotion on railways." W. E. Heys. (Communicated by J. J. Heilmann, France.) Dated March 12th. (*Complete.*)

5,157. "Improvements in apparatus for indicating the height of fluids in tanks or reservoirs by electricity." M. Mawson and A. Stuart. Dated March 12th.

5,158. "Improvements in splice coverings for electric wires." T. J. Dewees. Dated March 12th. (*Complete.*)

5,164. "Improvements relating to fittings for suspended electric lamps." A. Hoffmann. Dated March 12th.

5,194. "Improvements in the method of and apparatus for starting and stopping electric motors." T. R. Andrews and T. Preece. Dated March 13th.

5,203. "Improved electric-lit sights for night shooting, on sporting rifles and other guns." M. H. Galsworthy and S. S. Galsworthy. Dated March 13th.

5,217. "Improvements in phonographs and appliances connected therewith." A. C. Brown and G. R. Neilson. Dated March 13th.

5,218. "Improvements in the governing and construction of gas engines." H. J. Grice and E. Rollason. Dated March 13th. (*Complete.*)

5,226. "Improvements in or connected with electric batteries." C. P. Shrewsbury, F. L. Marshall, J. Cooper, and J. L. Dobell. Dated March 13th.

5,243. "Improvements in electric perforating pens." A. D. Lewis. Dated March 13th. (*Complete.*)

5,253. "Apparatus for electric lighting, ventilating, &c., by means of storage batteries and dynamos driven from car axles or other power of varying speed." W. L. Wise. (Communicated by I. N. Lewis, United States.) Dated March 13th. (*Complete.*)

5,254. "Apparatus for electric lighting, ventilating, &c., by means of storage batteries and dynamos driven from car axles or other power of varying speed." W. L. Wise. (Communicated by I. N. Lewis, United States.) Dated March 13th. (*Complete.*)

5,271. "Improvements in or connected with electric railways." E. H. Brown. Dated March 13th. (*Complete.*)

5,273. "Improvements in closed conduits for electric railways." R. W. Barker. (Communicated by the Lawrence Electric Company, United States.) Dated March 13th. (*Complete.*)

5,276. "Improvements in electric railways." J. F. Cummings and E. M. Engelman. Dated March 13th.

5,314. "Improvements in magnetic separators." S. L. Anderson. Dated March 14th.

5,340. "Improvements in the construction of electrical resistance coils." J. A. Fleming. Dated March 14th.

5,359. "Improvements in electrical signalling and in apparatus therefor." C. Balbiani. Dated March 14th.

5,363. "An improved form of alternating current dynamo." T. B. Grant. Dated March 14th.

5,375. "A new or improved method of regulating or varying the speed and or of twisting moment of electromotors and apparatus therefor." J. G. Statter. Dated March 14th.

5,401. "Improvements in and relating to fuel economisers." T. Sykes. Dated March 15th.

5,417. "A method of and apparatus for electrically signalling or transmitting a communication in the event of a fire or conflagration." J. T. Cockerill, and W. E. Bennett. Dated March 15th.

5,433. "Improvements connected with the insulation of electric conductors of armatures or other encased, enclosed or insulated electric conductors from which it is desirable to allow of the transmission of heat." H. Edmunds. Dated March 15th.

5,439. "Improvements in globes and shades for gas, electric and other lamps." H. Johnson. Dated March 15th.

5,442. "Improvements in lifts actuated or controlled by electricity." E. P. Okeden, of the firm of R. Waygood & Co. Dated March 15th.

5,449. "Improvements in connection with alternating current dynamos working in parallel." G. C. Fricker. Dated March 15th.

5,474. "Improvements in electric arc lamps." W. J. Davy. Dated March 15th. (*Complete.*)

5,493. "Improvements in gas and oil motor engines." J. Southall. Dated March 16th.

5,508. "Improvements relating to the transmission of signals through submarine telegraph cables." A. Muirhead. Dated March 16th.

5,509. "Improvements in the manufacture of submarine cables." A. Muirhead. Dated March 16th.

5,531. "Improvements in dynamo supports for portable and traction engines with locomotive type boilers." F. J. Burrell. Dated March 16th.

5,537. "Electrical deposition of zinc and alloys of zinc and apparatus therefor." R. Heathfield and W. S. Rawson. Dated March 16th.

5,572. "Elastic ear cushion for use on telephone receivers." F. Fearnley. Dated March 17th.

5,579. "Improved solutions for the electric deposition, separation and refinement of aluminium." J. Kirkwood. Dated March 17th.

5,592. "Improvements in counterweights for electric light pendants and other similar purposes." J. Grubb and W. H. Sturge. Dated March 17th.

5,619. "Improved construction or arrangement of bridge or support for electric wires, and in appliances for fixing or holding such wires in place therein." H. Bartels. Dated March 17th.

5,631. "Improvements in and connected with the electric lighting of trains and other vehicles." E. J. Preston and A. B. Gill. Dated March 17th.

5,637. "Improvements in electric accumulators." I. Chavanne. Dated March 17th.

5,643. "An improved telephone combination." Sir C. S. Forbes and the Domestic Telephone Company, Limited. Dated March 17th.

5,647. "Improvements in the manufacture of secondary coils for transformers." A. Schneller and W. J. Wisse. Dated March 17th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

1,391. "Improvements in electric arc lamps." K. Schleyder. Dated January 21st. The object of this invention is to provide a self-regulating electric lamp so constructed as to simplify the adjustment of the luminous arc. 4 claims.

1,948. "An improvement in secondary voltaic batteries." H. Imray. (Communicated from abroad by La Société Anonyme pour le Travail Electrique des Metaux, of Paris.) Dated January 28th. Claim:—The described mode of supporting the plates of a secondary voltaic battery by suspending them in the cell by shoulders at their upper parts resting on fillets on the cell walls so that they are free to expand and contract, their parallelism being maintained by grooves in which they loosely fit, and the electricity being conducted by an arm of each plate projecting upwards and laterally, and notched and tightened by nuts on a conducting bolt.

3,210. "Improvements in primary batteries, and in their application to miners' and like portable electric lamps." S. W. Maquay. Dated February 13th. The inventor employs horizontally arranged zinc plates or plates so arranged that their width is greater than their depth such as discs of metal used on the flat. These discs or plates are attached to rods or are otherwise suitably supported so that when in use they will be just under the surface of the liquid in the cell, which is a point where the liquid is most active while a very trifling lift will suffice to remove them therefrom. 5 claims.

3,402. "Improvements in electric meters." W. Clark. (A communication by the firm of Hartmann and Braun, of Frankfort-on-Main.) Dated February 15th. Relates to a meter for continuous and alternate currents wherein the indications of a wattmeter are transmitted at certain intervals to counting mechanism. 4 claims.

13,489. "An improved electric bell." B. Zeitschel. Dated July 11th. Claims:—1. The arrangement of the bell as described and illustrated, in which the case containing the contact mechanism and clapper, and the bell support parallel thereto and carrying the gong, are connected in a detachable manner, through the bobbins placed between them, by means of a nut. 2. A gong for electrical and mechanical bells, the section of which is of wave form, substantially as described and illustrated.

13,888. "Improvements in electric current and current generator governors." C. Wiese. Dated July 18th. The object of the invention is a direct acting automatic governor that will instantly relieve an electric circuit of any overcharge of current owing to the stoppage of a part of the consumption, or other cause, and also at the same time check the supply of steam, water, or other source, from which the power of the generators is derived by which the current is being furnished. 5 claims.

14,076. "Improvements in electric measuring instruments." H. H. Lake. (Communicated by A. H. Armen, of America.) Dated July 20th. The chief novel feature of the said instrument is the dial or face thereof having, in contra-distinction to the ordinary graduation in the form of an arc of a circle, a graduated index or gauge line subdivided into equal spaces and formed either in a straight line or in a descending geometrical curve, drooping centrally toward the axis of the pointer, and being in any case, a line other than the arc of a circle. 4 claims.

14,210. "An improvement in tubular posts for telegraphic or other purposes." Siemens Bros. & Co., Ltd., and C. E. J. May. Dated July 22nd. Claim:—For tubular posts, jointing together two tubes of different diameters by means of a split socket, having at the top a tapered internal screw thread, and at the bottom an internally coned ring, in combination with a split ring having a tapered external screw thread, substantially as described.

14,474. "Improvements in the arrangement of telephone circuits and in apparatus therefor." Sir C. S. Forbes. Dated July 27th. The object of the invention is to provide an economical and easily worked arrangement of telephone circuits whereby the members of a household, hotel, or other small community of persons may intercommunicate without the disadvantages incident to a central station and switchboard, with cost of its attendant for effecting interchange. 8 claims.

15,110. "Improvements in apparatus and devices for starting, stopping, and reversing electro-motors." F. A. Perret. Dated August 8th.